THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE III. VOL. IV.

No. X.—OCTOBER, 1887.

ORIGINAL ARTICLES.

I.—On the Discovery of the Larval Stage of a Cockroach, *Etoblattina Peachii*, H. Woodw., from the Coal-Measures of Kilmaurs, Ayrshire.

By Henry Woodward, LL.D., F.R.S., F.G.S.,
British Museum (Natural History).

(PLATE XII.)

BY the kindness of Mr. B. N. Peach, F.R.S.E., F.G.S., of the Geological Survey of Scotland, I have been permitted to examine a very interesting insect-remain enclosed in a light-brown nodule of Clay-Ironstone, obtained fram Kilmaurs, Ayrshire.

In February last[1] I had the pleasure to describe three new forms of British Carboniferous Cockroaches, viz.:—

1. *Etoblattina Johnsoni*, H. Woodw., Coal-Measures, Coseley, near Dudley.
2. *Leptoblattina exilis*, H. Woodw. do. do.
3. *Lithomylacris Kirkbyi*, H. Woodw., U. Coal-Measures, Meithil, Fife.

Mr. S. H. Scudder, of Boston, has described no fewer than 30 species from the Coal-Measures of N. America, whilst 41 species have been described by Goldenberg, Heer, Germar, Scudder, and others from the Coal-Measures of Europe, so that this group of Orthopterous insects was perhaps almost as well represented in the Coal-period as at the present day, and nearly as widely distributed geographically.

The present example from the Coal-Measures of Kilmaurs makes us acquainted with another entirely new form, measuring 23 millimètres in length, by 14 mm. in breadth, and exhibiting the minute head sunk in the rounded pronotum, a pair of rudimentary wing-covers, and a pair of rudimentary wings, which, as in other fossil cockroaches, are not differentiated from one another as they are in the modern Blattariæ.

The abdomen exhibits nine segments with broadly-expanded free-edges to their terga remarkably unlike the abdomen of most modern cockroaches.

The 8th and 9th segments are as large in proportion as those preceding them, thus differing markedly from living species, in which the terga of these segments are very narrow and are greatly overlapped by the 7th segment.

The 10th abdominal segment cannot be made out, but was probably present between the free-edges of the terga of the 9th segment.

Save the wings, no appendages are preserved.

[1] See Geol. Mag. 1887, Decade III. Vol. IV. pp. 49—58.

Detailed description.—The *pronotum* is nearly semicircular in outline, its anterior border being rounded and its posterior border straight. It is twice as broad as it is long.

The *head* is seen occupying a small rounded indentation in the centre of the anterior border of the pronotal shield. The epicranial plate is divided longitudinally down the centre; there is also a transverse furrow probably indicating the ocular and genal divisions.

Behind this notch in which the head lies, the pronotum is ornamented with two small slightly-raised prominences, and two small rounded depressions. Breadth of pronotum, 12 millimètres, length 5 mm. The *wing-covers* and *wings*, which are nearly alike in form and size, are each about 10 mm. in length, and about 5 mm. in greatest breadth. The mediastinal vein is seen in all 4 wings, also the veins of the Anal and the Internomedian area. The wings appear to conceal the whole of the mesonotum and the greater part of the metanotum. The length of the mesonotum and metanotum together is 6 mm.

The abdomen is 12 mm. in length by 10 mm. in breadth at its broadest anterior part. The segments 9 in number diminish in breadth rapidly, being only about $3\frac{1}{2}$ mm. in breadth at the posterior border. Fully half the breadth of the segments consists of the free-edges (epimera) of the terga, the body itself being not more than 5 mm. in breadth at the widest part, the terga making up the remaining 5 mm.

Compared with other fossil Cockroaches, the wings in this fossil Blatta have a close resemblance to those of *Blattina insignis*,[1] Gold. (Pl. XII. Fig. 3), from the Coal-Measures of Saarbrück (Rhenish Prussia); also to *Leptoblattina exilis*, H. Woodw., from the Coal-Measures of Coseley, near Dudley (Pl. XII. Fig. 2).[2]

I mention in my description of *L. exilis* (*op. cit.* p. 57) that "there is evidence of epimeral pieces to 3 of the segments," which would have greatly increased their width.

Compared with recent Cockroaches, there seemed at first but small hope of finding any form amongst living Blattinæ which would serve for comparison with this remarkable fossil; but through the kind assistance of Mr. W. F. Kirby, of the Zoological Department (British Museum of Natural History), I was referred to the figures and description of Blattariæ given by Brunner de Wattenwyl,[3] from the West Indies and Brazil, and particularly to one named *Blabera atropos*, by Stoll. This form, of which Brunner figures the male and female, and also the larva, presents in its larval stage[4] a close approach to our fossil example, not only in the rudi-

[1] "Fauna Sarepontana Fossils," Die fossilen Thiere aus der Steinkohlenformation von Saarbrucken von Dr. Frederick Goldenberg; Saarbruck, 1873. 4to. 1st Heft, mit 2 Tafelen (Taf. ii. fig. 14).

[2] See "Some New British Carboniferous Cockroaches," by Henry Woodward, Geol. Mag. 1887, Dec. III. Vol. IV. Pl. II. Figs. 2 and 3, pp. 56—58.

[3] Noveau Système des Blattaires, par Charles Brunner de Wattenwyl, Vienna, 1865, p. 375–6 and tab. xii. 55, A—G.

[4] *Op. cit.* tab. xii. 55, F.

ERRATA.

P. 435, line 5 from below, *for* fine *read* free.
„ 438, „ 9 „ „ „ *'these'* „ *'there.'*

mentary wings, but also in the great development of the free-edges (epimera) of the terga of the abdominal segments, so marked a feature in the fossil before us. (Compare Figs. 1 and 4, Plate XII.)

The Kilmaurs specimen, however, differs from the larva of *Blabera atropos* (Stoll), in the presence of the anterior notch of the pronotum in which the head is visible; in the larger size of its wings and the ornaments on the segments of the abdomen in the living form and the difference in the ornament on the pronotum.

In the character of the neuration of the wings in the adult of *Blabera atropos* one cannot but be struck with its resemblance to the neuration of *Etoblattina* amongst Coal-measure forms of Blattariæ.

Seeing that there can be little doubt that we are here dealing with a larval form, it may be well to place it provisionally under the genus *Etoblattina*, and I cannot think of a more suitable specific name to propose for it than that of the geologist from whose hands I received it. I therefore name it *Etoblattina Peachii*, after that most able naturalist and geologist, Mr. B. N. Peach.

EXPLANATION OF PLATE XII.

Fig. 1. *Etoblattina Peachii*, H. Woodward, sp. nov. (enlarged three times), Coal-Measures, Kilmaurs, Ayrshire.
,, 2. *Leptoblattina exilis*, H. Woodward, Coal-Measures, Coseley, near Dudley.
,, 3. *Blattina insignis*, Goldenberg, Coal-Measures, Saarbrück, R. Prussia.
,, 4. Larva of *Blabera atropos*, Stoll, Brazil, view of upper side.
,, 5. The same larva seen from beneath.

II.—On the Organic Origin of the Chert in the Carboniferous Limestone Series of Ireland, and its Similarity to that in the Corresponding Strata in North Wales and Yorkshire.

By George Jennings Hinde, Ph.D., F.G.S., etc.[1]

THE first references in any detail to the nature of the Chert in Carboniferous rocks appeared in 1878,[2] when Messrs. Hull and Hardman published a joint paper on the subject, treating more particularly of the Chert in the Upper Carboniferous Limestone of Ireland. Prof. Hull gave a general description of the distribution and mode of occurrence of the Chert, and a detailed notice of its microscopic structure, as shown in fifteen thin sections of the rock from various localities in Ireland. The author reached the conclusion that the Chert is essentially a pseudomorphic rock, consisting of gelatinous silica replacing limestone of organic origin, chiefly foraminiferal, crinoidal, and coralline; the replacement was believed to have taken place before the shales overlying it were deposited, whilst the limestone was in a more or less plastic condition, admitting the free percolation of water holding silica in solution. The sea was believed to have been largely charged with silica in solution,

[1] Paper read before the British Association at Manchester.
[2] Scientific Transactions of the Royal Dublin Society, vol. i. n.s. 1878, pp. 71-94, pl. iii.

and the chemical process was accelerated by the warm surface waters of a shallow sea. The origin of the Chert from the siliceous skeletons of Diatomaceæ, Polycystinæ, and the spicules of sponges is distinctly denied, and it is affirmed that it can only be considered as a secondary product due to the replacement of lime-carbonate by silica.

Mr. Hardman gave, in his part of the paper, the results of numerous analyses of the rock, showing that it consisted principally of anhydrous silica, reaching up to 95·5 per cent., with a varying admixture of carbonate of lime, iron, and a few other minerals. Judging from its chemical constitution, Mr. Hardman considered that the formation of Chert can only be accounted for by a process of pseudomorphism in limestone, and "supposing that the ocean in which the limestone was being formed contained an unusually large percentage of silica, it is but natural to suppose that the water would elect to dissolve small portions of the more easily soluble carbonate of lime and in their place to deposit equivalent portions of the less soluble silica in the gelatinous state" (*op. cit.* p. 92).

Shortly after the appearance of the paper just referred to, M. Alphonse Renard, of Brussels, published, in a paper entitled[1] "Recherches lithologiques sur les Phthanites du Calcaire Carbonifère de Belgique," the results of an examination of the same kind of rock in the Carboniferous Limestones of Belgium. This author very carefully studied the macroscopic and physical characters of the Chert, and he reached nearly the same conclusion respecting its origin as that of Messrs. Hull and Hardman, viz. that the phthanites (as the Chert beds are technically termed) have been formed by the silicification of the organic and inorganic calcareous elements which composed the limestones, and that this more or less complete pseudomorphosis has taken place at an epoch when the sediments, although retaining a certain amount of plasticity, already possessed the structure which may be seen in the normal Carboniferous Limestone. The author further adds, that it is impossible to explain the formation of phthanites by the accumulation of organisms with siliceous skeletons, and there[2] was nothing to prove that the silica which had infiltrated into the limestone was derived from the decomposition of the spicules of sponges or the frustules of diatoms.

I may just remark that the observations of M. Renard on the characters of the Chert or phthanites appear to have been very carefully and thoroughly worked out, and it is not to these but to the theoretical conclusions as to the inorganic origin of the silica of the Chert that I venture to take objection.

Since 1878, no special memoir on the nature of the Carboniferous Chert has appeared, but a curious commentary on the statement of Prof. Hull that this Chert was not derived from siliceous organisms such as the spicules of sponges, was afforded by the discovery by Prof. Sollas,[3] that some of the very sections described and figured in Prof. Hull's paper were so constituted of sponge-spicules that

[1] Bulletin de l'Académie Royale de Belgique, 2 s. t. 46, pp. 471-498, pl. i.
[2] *Op. cit.* p. 498.
[3] Ann. and Mag. Nat. Hist. vol. vii. (1881) p. 141.

they made up the larger part of the Chert. Another fact, also bearing on the probable organic character of the Irish Carboniferous Chert, was the discovery by Messrs. Wright and Stewart of Belfast of beds of siliceous clay, apparently resulting from decayed Chert, which were described by Mr. H. J. Carter, F.R.S.,[1] as in some parts nearly entirely composed of sponge-spicules.

In a paper[2] showing the derivation of the Chert in the Lower and Upper Greensand of the South of England from the remains of siliceous sponges published in the Phil. Trans. for 1885, I ventured to suggest that the facts above stated justified the conclusion that the Carboniferous Chert of Ireland would be found to be likewise of organic origin, and that therefore Messrs. Hull and Hardman were probably wrong in regarding it as of inorganic derivation. This suggestion has been warmly combated by Messrs. Hull and Hardman in two short papers brought before the Royal Society,[3] and lately published in its Proceedings. Prof. Hull states, in the paper referred to, that there is absolutely no evidence that the silica of the Irish Carboniferous Chert has been derived from sponge-spicules; that there is only a fanciful analogy between the Carboniferous Chert-beds and the sponge-beds of the Cretaceous formation; that as sponges were rare in the Carboniferous rocks, it is clear that they could have taken no important part in the formation of the Chert-bands in the Carboniferous Limestone; and the assertion I made is therefore unfounded, and I must have mistaken sections of crinoid stems for sponge-spicules. Prof. Hull still maintains and reasserts his original proposition, that the beds and nodules of siliceous material in the Carboniferous Limestones of Ireland have been formed by a direct replacement of the original calcareous substance of the limestone itself by silica held in solution in the sea-water, without the intervention of siliceous organisms.

It is somewhat remarkable that neither Prof. Hull nor Mr. Hardman make any mention whatever in these papers of the fact, published by Prof. Sollas, that in at least two of the specimens of Chert in Prof. Hull's own possession, sponge-spicules make up the larger part of its substance. This fact alone is quite sufficient foundation for the assertion I made, and Prof. Hull was in duty bound to give some explanation of it, before accusing me of making a statement on absolutely no evidence. It is manifest that[4] Prof.

[1] Ann. and Mag. Nat. Hist. s. 5, vol. vi. (1880) p. 213.

[2] On Beds of Sponge-Remains in the Lower and Upper Greensand of the South of England, Phil. Trans. pt. ii. 1885, pp. 405-453, pls. 40-45.

[3] Proc. Royal Soc. vol. xlii. p. 304, et seq.

[4] I regret to have to make another serious complaint against Prof. Hull of having misquoted a passage from my published paper in the Phil. Trans., leaving out words essential to its meaning, and then stating that he has quoted the entire passage to avoid the possibility of misinterpretation, and that it is altogether unintelligible! The passage in question, at the bottom of page 432 in my paper, is as follows, "Thus Dr. Bowerbank held that the sponges imbedded in the Chert of the Greensand possessed horny and not siliceous skeletons, and that the silica of the Chert in which they were imbedded was attracted from the exterior medium by the animal matter and not secreted therefrom by the living sponge." In Prof. Hull's quotation the last paragraph runs thus, "The silica in the Chert in which they were imbedded was

Hull had clear evidence in his own possession; that its nature had been publicly pointed out by Prof. Sollas; and that he has entirely ignored it in his reply to my statement.

As I have been engaged during this last year in an investigation of the character of the Carboniferous Chert of Yorkshire and North Wales, which proves to be unequivocally of the same organic nature as the Chert in the Cretaceous strata of the South of England, this emphatic denial of the organic origin of the Carboniferous Chert in Ireland by the Director of the Irish Geological Survey made me desirous of examining for myself the character of the rock in question, and with this end in view, I visited during this last July the various localities in Ireland in which, according to Prof. Hull, the Chert in the Carboniferous series is best developed, and I propose now to give a short notice of the observations I made in the field, and also of a microscopic examination of the specimens I collected. Time has not allowed me to work out fully the results of my studies of the English and Welsh Carboniferous Chert, and I shall only make a brief reference to these rocks at present; but the specimens I have brought will enable any one to see how close is the resemblance in general characters between the same rock from the different countries.

Before starting on my search, I called at the Office of the Geological Survey in Dublin, and through the courtesy of Prof. Hull, for which I tender him my best thanks, I was allowed to examine under the microscope the series of sections of Carboniferous Chert prepared for his original description of the rock, including the two, in which, according to Prof. Sollas, sponge-spicules make up the larger part of the Chert. I can fully substantiate this statement of Prof. Sollas, not only as regards the specimens which he examined, but in others as well; the sponge-spicules in the slides are mostly shown in transverse section and their characters are unmistakeable.

It is somewhat strange that with specimens filled with sponge-spicules before him Prof. Hull should not in his paper have made a single mention of these structures beyond denying that they had anything to do with the structure of the rock. If we compare the original specimens with the descriptions given of them, the mistake made by Prof. Hull is at once apparent. Thus, for example, the section of the brownish and banded Chert from Ballymote, County Sligo, represented on fig. 4 of the plate, is stated to contain "circular disks of crinoids, sometimes with dark central nuclei,

attracted from the exterior medium by the animal matter, and not secreted from the living sponge." In the original I distinctly state that the living sponge secreted the silica now forming the Chert from the exterior medium (*i.e.* the sea-water). In the quotation, Prof. Hull omits the important words '*these*' and '*by*,' and then accuses me of not stating that the silica was originally derived from the sea-water!

Again, Prof. Hull on page 305 of his paper gives as a quotation from my paper, between inverted commas, the following passage, "The beds and irregular masses of Chert have been derived solely from the silica of the sponge-remains, instead of from that held in solution by the sea-waters themselves." This passage, quoted as a verbatim extract, does *not* occur in my paper, and is not even a fair representation of my meaning, which will be seen by turning to pages 432, 3, to be, that the silica of the Chert was not derived *directly* from that held in solution in the sea-water.

obscure forms of foraminifers in section, coralline structures? and bivalves (brachiopods) with crystalline silica in interiors," etc. In the original of the figure, however, sections of crinoid stems do not appear, and it is evident that the forms described as "circular disks of crinoids with dark central nuclei" are really transverse sections of sponge-spicules, and the central nuclei are sections of their axial canals! These are abundant enough in the section. A similar mistake vitiates the descriptions of the other sections, and the supposed Crinoidal stems are, in most instances, the spicules of sponges! When a chance section of the ossicle of a Crinoid does occur in Prof. Hull's slides, the distinction between it and a sponge-spicule is readily apparent, for not only is the Crinoid fragment much larger, but it also exhibits the minute cribriform structure peculiar to Echinodermal organisms, which is so well known to every tyro in the microscopical study of organic rocks, and serves to mark them off from sponge-remains. Prof. Hull has charged me, and erroneously, with mistaking sections of Crinoids for sponge-spicules, but it is evident that he was himself really committing the converse mistake of describing the sponge-remains in his own specimens as portions of Crinoids!

As Prof. Hull's specimens were selected without any reference to their composition, and as they have been brought forward as evidence of the inorganic origin of the silica of the Chert, the fact that some are found filled with siliceous spicules may fairly be taken as a strong argument from a perfectly independent source that the Carboniferous Chert is really derived from the silica of sponge remains.

The Chert in the Irish Carboniferous Limestone is mainly developed in the Upper Division or Upper Limestone, which[1] Prof. Hull regards as the equivalent of the upper portion of the Carboniferous Limestone in England, the shale beds intervening between this Upper Limestone and the Millstone Grit being considered by him as the representatives of the Yoredale beds of Yorkshire. As a fact, however, the Yoredale series in its typical region mainly consists of beds of limestone associated with beds of Chert, often of considerable thickness; these limestone and chert beds are of a similar character to those of the so-called Upper Limestones of the Irish series, and it is therefore reasonable to conclude that these Chert-bearing Upper Limestones are the equivalents in the geological scale of the Chert-bearing limestones in the Yoredale series of Yorkshire and North Wales.

According to the reports of the Irish Geological Survey, beds of Chert are very generally distributed in the Upper Limestones of the south-western districts of Tipperary, Limerick, Kerry, and Cork, but I had no opportunity of visiting these counties, and my observations were limited to the Chert in the Limestones in Queen's County and Kilkenny to the south, and in the Counties of Fermanagh and Sligo to the north-west of Ireland, from whence Prof. Hull obtained the specimens on which he has founded his

[1] *loc. cit.* p. 73.

theory of its inorganic origin. I also examined the Chert in the Carboniferous Limestones in the vicinity of Dublin, which, though coloured in some of the Geological Survey Maps as belonging to the Upper Limestone series, forms part, as I was informed by Prof. Hull, of the Middle division, or Calp series.

The mode of occurrence and the physical characters of the Chert are in the main similar both in the south and in the north-west of Ireland. It is usually exposed on the flanks and summits of some of the principal hills which have partially escaped the severe glacial erosion to which the country has been subjected, and their preservation may, in part at least, be attributed to the compact resistant nature of the Chert and Cherty-limestones of which they are composed. The Chert often occurs as nodular masses of irregular form, inclosed in beds of hard bluish Limestones, and following the planes of bedding, much in the same way as the flints in the Upper Chalk; but unlike the flints, these nodular masses are not sharply delimited from the Limestones in which they are interbedded, but there is a gradual passage from the Chert to the Limestone.

More frequently, however, the Chert exists in definite beds, from one to five inches (·025–·12m.) in thickness, which intervene at irregular intervals between beds of Limestone. These beds sometimes occur also as well-marked layers in the central portions of beds of Limestone. Both the nodular aggregations and the horizontally-bedded Chert usually occur in the same series of rocks; the particular mode of deposition probably depends on the extent to which the sponge-remains (of which it will be shown the Chert consists) are present in the respective areas.

Owing to this irregular mode of deposition, it is difficult to arrive at an estimate of the total thickness of the Irish Carboniferous Chert. Nowhere have I seen a continuous series of beds like those in North Wales and Yorkshire; the Chert in Ireland was more interrupted by the deposition of Limestones, but its aggregate thickness may not fall much short of the beds in Yorkshire.

On the sides of the hill of Knock-na-Rea, near Sligo, Chert occurs at frequent intervals, both in beds and nodular masses throughout the series of Limestone, about 800 feet (240m.) in thickness, forming the upper portion of the hill, and at Ben Bulben to the North of Sligo Bay, the Limestones, in the higher slopes, about 600 feet (180m.) in thickness, also contain an abundance of Chert. I should estimate the Chert to vary from one-tenth to one-fifth of the total thickness of these beds. On the sides and summit of the hill of Benachlan, Florence Court, near Enniskillen,[1] Prof. Hull estimates that the Chert-bands in the Upper Limestone series may have a thickness of 150 feet (45m.) out of a total thickness of 400 feet, but from my own observation I should judge that this estimate is considerably too high. In the South of Ireland the upper portion of the Upper Limestone series consists, according to the reports of the Geological Survey,[2] nearly entirely of a mass of Chert from

[1] Proc. Royal Soc. vol. xlii. p. 306.
[2] Explanation of Sheet 128 (1859), p. 11.

30 to 50 feet (9 to 15m.) in thickness. As the total thickness of the Upper Limestone series, in which the Chert is mainly developed, is from 600 to 800 feet, there is probably an aggregate thickness of 100 to 150 feet of Chert (30–45m.), and in addition to this there is a considerable thickness of Chert in the Middle or Calp series of Limestone.

There is considerable uniformity in the character of the Chert in the Carboniferous series of Ireland. It is, for the most part, a compact, dark rock, it breaks with a conchoidal or splintery fracture, is too hard to be scratched with a knife, and, as a rule, gives no action with acid. The fractured surfaces are usually dull, sometimes with a faint lustre, resembling the so-called Lydian Stone. Horizontal lines of banding are not often shown in it. The beds are sometimes traversed by minute thread-like fissures, now infilled with quartz. The upper and under surfaces of the beds weather into a light grey or whitish siliceous crust, in some cases nearly an inch (20mm.) in thickness, of a porous granular material, harsh to the feel, and adhesive to the tongue, which strikingly contrasts with the black compact Chert of the central portion of the beds. In cases of extreme weathering, the entire mass of the Chert is converted into this porous rock, it then has a pumice-like aspect, and is relatively very light.

In the case of cherty limestones, in which the shells of Brachiopods, Crinoid stems and other calcareous organisms have been imbedded, the calcareous structures are entirely removed by weathering, and the impressions of the fossils are distinctly shown in the siliceous matrix.

In some cases the Chert has a light brownish tint; it is equally as hard as the black Chert, and weathers out in a similar manner. In Queen's County and Kilkenny some of the nodular masses, and beds of Chert as well, are of a grey or bluish grey tint, the beds are much jointed, and thin films of calcite have formed in the joint-planes. Occasionally the siliceous rock occurs in the granular porous condition in the limestones, it does not appear to have reached the stage of compact Chert. When treated with acid or when weathered out naturally, the siliceous portions stand out from the limestone in the same way as the porous crust on the solid Chert.

I have not had any chemical analysis of the Chert prepared, those carried out by the late Mr. Hardman[1] being sufficient to show its mineral composition. In several of these analyses the proportion of insoluble silica varied from 90 to 95 per cent., the residue consisting of carbonate of lime, iron, alumina and magnesia. In less pure Chert the proportion of silica diminished, whilst that of carbonate of lime increased, and some of the rocks analyzed were rather limestones than Chert. Prof. Hull states from his microscopic observations that the silica of Chert occurs in a gelatinous or colloid condition.[2] The chemical analyses of Mr. Hardman[3]

[1] Scient. Trans. Royal Dublin Soc. vol. i. 1878, pp. 86-91.
[2] Op. cit. p. 84.
[3] Op. cit. p. 92.

show, however, that in all cases the silica present is in the insoluble form, and he seems to have been puzzled to reconcile this fact with the preconceived notion that it was in the amorphous or soluble condition. The sections of the Irish Chert which I have examined between crossed Nicols all show the optical characters of chalcedony and quartz, and thus substantiate the accuracy of Mr. Hardman's analyses; it is therefore probable that Prof. Hull's statement that the silica is now in a colloid condition is founded on some mistake.

In order fairly to ascertain the microscopic structure of the Chert I had sections prepared, from specimens obtained from every locality I visited, including Dublin. The localities comprised Dunamase, near Maryborough, in Queen's Co.; Bonnet's Rath, near Kilkenny; Keishcorran, near Ballymote; Knock-na-Rea, and Ben Bulben in the County of Sligo, and also Benachlan, Florence Court, near Enniskillen.

Nearly all the sections were prepared from the prevalent dark Chert. This, when viewed by reflected light under the microscope, showed a diffused, cloudy, bluish-white reticulation on a dark ground. By transmitted light the bluish portion becomes translucent, and when the section is very thin, transparent. It is resolved into microscopic sponge-spicules, confusedly intermingled together, whose individual outlines can be traced with varying degrees of clearness. In transverse section the spicules appear as well-defined circles, with, in many cases, a central spot indicating the axial canal of the spicule. In longitudinal section, the larger spicules exhibit two parallel lines with a clear space between them, but viewed in this direction the individual forms are much less distinct than when seen transversely. In most of the sections under examination, sponge-spicules are the only organisms visible, in some there is a slight admixture of specimens of the genus *Fenestella* and other Polyzoa, the cells of which are now filled with either chalcedony or quartz, rarely also there are fragments of minute Brachiopod or Entomostracan shells, and one or two microscopic ossicles of Crinoids, but I have not recognized Foraminifera in my sections.

The dark material in the Chert is for the most part disposed in wavy bands, following the plane of bedding. Some of it consists of very minute opaque crystals, but for the most part it has a cloudy appearance. It appears to me to be partly of a carbonaceous and partly of a ferruginous character. As already mentioned, this dark material disappears in the weathered outer crust of the Chert, and even the *central* portion of black Chert beds becomes bleached after exposure.

Sections of the light-brown Chert from Benachlan contain, in addition to spicules, numerous well-defined microscopic cubic and rhombic crystals, either entirely or partially transparent or opaque; they vary from ·02 to ·075 mm. in diameter; similar crystals are also present in the dark Chert, but in fewer numbers. In this brown Chert the spicules have a brownish cloudy aspect in transmitted light; their outlines are extremely jagged, showing that solvent action has reduced them to mere skeletons of their original forms.

In all the sections of Chert which I had prepared sponge-spicules are present; in some their traces are indistinct and objection might be raised that the few forms visible are insufficient to justify the conclusion that the rock has been derived from these organisms. In other slides of precisely the same kind of rock in outer appearance, the spicules are so abundant that it must be conceded that, as Prof. Sollas remarked of some of Prof. Hull's specimens, they make up the larger part of the Chert. But even in the best-preserved specimens of the Irish Chert, the spicules have suffered from the influences of fossilization, and many are passing into various stages of dissolution, and there are good grounds for supposing that in the specimens which only show the spicules faintly, they have become nearly obliterated through subsequent changes in the rock.

I have discovered evidence strongly confirmatory of this view, in the nature of the porous crust, which, as already mentioned, results from weathering action on the surfaces of beds of Chert. In most cases, this crust appears to consist only of minute siliceous grains, but under favourable conditions of preservation, it is seen to be composed of innumerable minute rod-like sponge-spicules, intercrossing, and as it were felted together irregularly in the plane of the bedding of the rock. Also the layers of porous siliceous rock, which, as already noticed, in some cases appears to take the place of the compact Chert in the limestone, are likewise seen to consist of matted masses of minute spicules.

In the cases just mentioned, the evidence in favour of the view that the silica of the Chert is derived from the accumulation of the skeletal elements of siliceous sponges, and not as a *direct* deposit of this mineral from solution in sea-water, is demonstrable and conclusive. We can see in these instances that the silica of the Chert is distinctly of organic origin; the sponges have by vital action secreted the silica to form their spicules, and whilst some of these still retain their forms, others have been partially or completely destroyed to form the siliceous matrix. These spicular crusts also prove the presence of these bodies in the central mass of the beds of Chert, even when they cannot be distinguished in microscopic sections.

The preservation of the sponge-remains in the Irish Carboniferous Chert is much less favourable than in the corresponding Chert-beds of the Yoredale series in Yorkshire and North Wales; the spicules are far more eroded, and consequently it is more difficult to determine their characters. They appear to be nearly entirely minute acerate and cylindrical spicules varying from ·3 to ·9 mm. in length, and from ·017 to ·12 mm. in thickness. Most of these spicules probably belong to the Monactinellidæ, though some of the larger forms may be those of Tetractinellid sponges. Occasionally slender filiform spicules are present which attain a length of 2 mm., though only ·05 mm. in thickness.

Not a single entire sponge has, as yet, been discovered in any of the Chert-beds referred to, and though masses of rock reaching, as we have seen, an estimated thickness of 100 to 150 feet (30–45 m.)

are built up by these organisms, the portions preserved do not suffice to determine satisfactorily a single species. The sponges, like those in the Cretaceous rocks, have lived for successive generations on the areas of these Chert-beds, and after the death of the animal and the decay of the soft structures, the microscopic spicules of their skeletons have gently fallen and intermingled together on the sea-floor. When the sponges have existed continuously and nearly exclusively in the same area for long periods, massive beds of Chert have been produced by the accumulation and partial solution of their spicules; where, however, the sponges have grown in association with Crinoids and Polyzoa, then the Chert is in nodular aggregates, or the interspaces between the Crinoidal and other calcareous structures have been filled up by the silica resulting from the partial solution of the sponge-remains producing Cherty limestones.

Under certain conditions, however, when the calcareous portions of the rock much exceed the sponge-remains, these latter are frequently partially or entirely dissolved and replaced by calcite. This substitution has taken place in some of the dark limestones of the Calp series near Dublin, in which by the aid of a simple lens numerous spicules can be detected, but on treating the rock with acid, the spicules are dissolved away equally with the limestone matrix, leaving only a few small hollow fragments in the residue. The spicules in this limestone are considerably larger than those in the Chert-beds, and appear to belong mostly to Tetractinellid sponges.

It is not my intention to enter now into a detailed comparison of the Irish Carboniferous Chert with that in the Yoredale series of Yorkshire and North Wales; it will suffice to state that in all essential features the rocks from these different localities are very similar, so that in many cases it would be impossible to distinguish hand-specimens of the Irish from the Welsh Chert. The organic nature of the English and Welsh Carboniferous Chert, as produced from sponge-remains, is far more distinctly shown than in the case of the Irish beds, for the spicules are much better preserved, and the beds have been less altered by fossilization. Sponge-life also has been more continuous in the Yorkshire and North Wales areas, or, at all events, these organisms have been less intermingled with Crinoids and other animals possessing skeletons of carbonate of lime, so that their remains form continuous series of Chert-beds. In some of the Yorkshire areas there are beds of Chert 18 feet (5·4m.) in thickness without a break, and in North Wales there is a continuous series 350 feet (105m.) in thickness, without the intervention of Limestones. I hope shortly to give a detailed notice of these remarkable and hitherto unequalled sponge-beds, which, alike with those in the Irish Carboniferous rocks, conclusively show that in the interval between the Carboniferous Limestone proper and the Millstone Grit, siliceous sponges existed in greater force and played a more important part as rock-builders, than at any subsequent geological period.

The organic nature of these Carboniferous Chert and siliceous rocks, though strenuously denied by some geologists, has been

frequently suspected by others, but no satisfactory proof has been heretofore brought forward to decide the question. I think, however, that the evidence which I have now collected from so many quarters will be found sufficiently conclusive to set at rest all objections to their organic origin.

I am not in a position to discuss how far the British Cherts correspond with the phthanites of the Carboniferous strata of Belgium, but judging from the careful description given of the latter by M. Renard, the resemblance is very close, and in my opinion the phthanites will be found to have the same origin as our Cherts. I have some grounds for this belief from the fact that in sections of a hand specimen of phthanite from the Carboniferous rocks at Namur, which was kindly sent to me by Dr. C. Barrois, there are abundant remains of sponge-spicules, and in transverse sections they correspond closely with those figured by M. Renard in illustration of his paper. Most of these spicules, however, are now so fragmentary and altered, that they would not be recognized as such by any one unfamiliar with the changes produced in them by fossilization.

I wish in conclusion shortly to notice some of the arguments brought forward by Messrs. Hull and Hardman and by M. Renard in favour of what may be called the chemical theory of Chert, which is that the silica of which it is composed is a direct deposit from the stores of this mineral held in solution in the sea-water, without the intervention of organic life. According to the explanation given by M. Renard,[1] at certain intervals the waters of the Carboniferous sea, holding in solution carbonic acid, a solvent of calcite, attacked the calcareous material, the silicic acid being infiltrated into it, and taking its place in proportion as it was decomposed. Prof. Hull distinctly states that the Chert is essentially a pseudomorphic rock consisting of gelatinous silica replacing limestone of organic origin.

I am unable to recognize the evidence for the statement that the silica of the Carboniferous Chert is a pseudomorph after limestone. In the beds of pure Chert, that is, when there is scarcely any admixture of carbonate of lime, hardly any traces of organisms other than sponge-spicules can be distinguished. According to the transmutation theory these Chert-beds were originally organic limestones, and should now show in silica the forms of their original structures; but, unfortunately for the theory, there are scarcely any present in them. In the Cherty limestones, calcareous organic structures are plentiful, but curiously enough, even here, there has been little replacement. Silica has indeed infilled the vacant spaces in the cells of the Polyzoa and the stems of the Crinoids, but it has not, as a rule, replaced the calcareous structures themselves. This is clearly shown when the Cherty limestones are exposed to atmospheric influences by which the calcareous structures in them are dissolved away and removed, leaving perfect moulds of their forms in the siliceous matrix, which is now in the form of rottenstone. If they

[1] Bullet. de l'Acad. Roy. de Belgique, 2me s. t. 46 (1878), p. 497.

had been replaced by silica on the transmutation theory, they would not thus be dissolved out. I fully admit that the substitution of silica for calcite is of common occurrence, but in the case of these Carboniferous Cherty limestones it does not seem to have taken place to any great extent.

The main argument brought forward by Prof. Hull,[1] in his lately published paper, against the derivation of the Chert from sponge-remains, is stated to be "based on the fact that the development of sponge-life in the Carboniferous period was insignificant, and quite inadequate to account for the existence of bands and masses of Chert, sometimes constituting almost a half or third of the entire mass of the Upper Limestone."

But in what manner did Prof. Hull set himself to ascertain the fact that the Sponge-life in the Carboniferous seas was insignificant? With great pains he compiles lists of the numbers of species and genera of sponges and calcareous organisms in the Carboniferous and Cretaceous formations respectively, and he finds an "enormous proportion of siliceous sponges in the Cretaceous as compared with those in the Carboniferous period." Further, in the Carboniferous period, "the species of siliceous sponges might almost be counted on the fingers of the two hands; both in genera, species and individuals they are quite unimportant as compared with the calcareous organisms of that period, and totally inadequate to supply materials for the formation of such beds of Chert as are formed in the Carboniferous Limestone formation."

It seemed to me, however, that this method was rather an unsafe one to determine a question of this character, and that even in the hands of a Director of the Geological Survey, in his own field of investigation, a satisfactory result would not be obtained by figuring up lists of species, and then doing a rule-of-three sum with the totals. I ventured to think that it would be more satisfactory to ask the question whether sponge-life was insignificant in the Carboniferous period, of Nature herself, and so, with the limited time and resources at my disposal, I went to the rocks in Ireland and collected the evidence which has been brought forward in this paper. I leave it to the reader to determine whether my plan, or that of the Director of the Irish Survey, is most to be relied on, and whether, as Prof. Hull states, there is absolutely no evidence beyond a fanciful analogy for the organic origin of the Carboniferous Chert of Ireland.

III.—The Growth of Cephalopod Shells.

By F. A. Bather, B.A., F.G.S.,
of the British Museum (Natural History).

THE shells of Cephalopods form an evolutionary series, traceable to an ancestor unknown, but nearly related to not yet coiled forms of the Cambrian. In all descendants from this common stock homologous parts are discerned. Hence facts regarding the growth of any one form may be applied to all. Of Cephalopods with chambered shells only *Nautilus*, *Spirula*, and *Sepia* exist. *Spirula* is

[1] Proc. Royal Soc. 1887, vol. 42, p. 306.

so rare and its shell so retrograde that no theory has yet been built on it. Examination of *Nautilus* gave rise to the Secretion-hypothesis, shortly stated as follows:—As the animal grows, the adherent muscles and the cincture gradually advance, the siphuncle lengthening in proportion; thus a cavity is formed between the last septum and the surface of the visceral hump: this latter then deposits calcareous matter, beginning at the sides of the shell and proceeding towards the siphuncle round which it is continued backward. During the advance of the animal the anterior portion of the mantle secretes calcareous matter, which it deposits in successive layers on the margin of the aperture (Edwards and Wood).

Microscopical examination of the fresh Sepion has led Dr. E. Riefstahl to propose what may be called the Intussusception-hypothesis:—That each new septum is absolutely developed from the preceding, and is removed therefrom by growth of the intervening zone of the outer shell wall; which growth is effected, not by apposition, but by intussusception (The Sepion and its relations to Belemnites, Palæontographica, Bd. 32, 1886). Startling though this be, the minuteness of the investigation demands attention. His paper consists of (*a*) description of minute structure of the Sepion; (*β*) conclusions as to its mode of growth; (*γ*) establishment of homologies with the Belemnite, thus bringing those conclusions to bear on external shells.

FIG. 3.

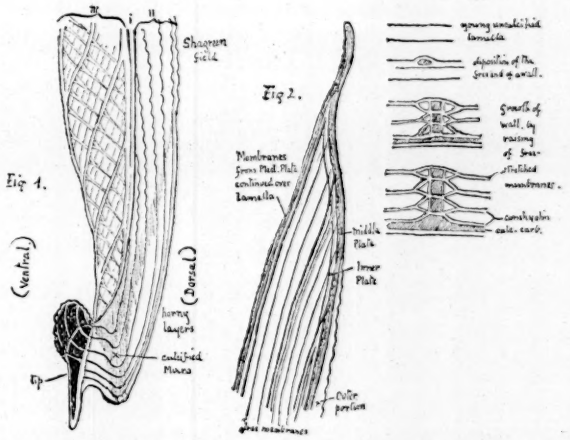

FIG. 1. Sagittal section, posterior end of young Sepia shell. Diagram after Riefstahl.
FIG. 2. Sagittal section, anterior margin of Sepia shell: the partitions not shown.
FIG. 3. Development of sinuous partitions. Diagram after Riefstahl. The thickness of the free membranes is exaggerated.

(*a*) The Sepion is a complex of conchyolin membranes, impregnated with lime in varying degrees: in accordance with the extent and mode of calcification three parts are distinguished (Fig. 1.)—i. Middle plate; calcification slight and not extended to the margin; ii. Outer portion, dorsal; membranes parallel and overlapping,

stiffened in definite tracts by calcareous discs to form an anterior "shagreen field" and a posterior "mucro"; iii. Inner portion, ventral; chiefly consists of the so-called "spongioid tissue"; in sagittal section the organic membranes forming this are seen to be in groups; in each group the ventral membranes lie close together and are supported by a calcareous lamina of prismatic structure, thus forming a "lamella"; the remaining membranes are stretched freely at regular intervals; between the lamellæ, at right angles to them, are calcareous "sinuous partitions," which radiate towards the margin; through these the free membranes pass, and are by them supported: decalcification shows that all the membranes are continuous with those of the Middle plate (Fig. 2).

(β) The Outer portion is secreted by the mantle; its form is determined by that of the Inner portion. Secretion does not explain the growth of the Inner portion: the last formed lamellæ lie more closely on one another than do those of earlier age; the spaces between the freely-stretched membranes are not smaller, but the number of those membranes is less, they are absent from at least the hinder edge of the last formed lamella; hence the partitions are shorter, and the space between the insertion-lines of the two last lamellæ is less than in other parts of the shell (Fig. 2); each partition is bifid ventrally, this end is the first to appear. It follows that the membranes are separated from the lamellæ, not secreted by the mantle; and the calcium carbonate is only deposited on the inner, *i.e.* dorsal, side of the conchyolin (Fig. 3): the subsequent sundering of the lamellæ is accounted for by intussusceptional growth of the shell.

(γ) The Outer portion equals the Belemnite guard; the Inner portion the phragmocone, the lamellæ being septa; the Middle plate was represented by an *epicuticula* of the phragmocone: this is confirmed by fresh details. Hence in all chambered shells the hinder end of the body is in continuous contact with the youngest septum, and the subsequent sundering of the septa is effected by the growth of those zones of the shell-wall that lie between the sutures.

Thus far Riefstahl.

Undeniably there are objections to the Secretion-hypothesis, such as the complex structure of nacre, especially when freely-stretched membranes are present. But neither alternate secretions of lime and gas or, as in *Sepia*, liquid, nor alternate deposition of lamellæ and partitions are so absurd as Riefstahl maintains. Despite their regularity, due to advance of structure and function, we need not think the septa of Cephalopods originally different from those of some Gasteropods. Still the chambers of a *Nautilus* have, thanks to the siphuncle, a vitality denied to the septate portion of a *Bulimus*; here Riefstahl's conclusions harmonize with those of F. Müller on shell formation in Lamellibranchs: "The shell is no product of secretion, but has independent life, and grows by intussusception" (Zool. Beitr. Breslau, 1885, p. 206). Yet the avascular nature of the shell renders it hard to credit elaboration of lime in parts removed from the animal, nor is it to be thought that the latter is wholly idle;

in *Sepia* the inner surface of the mantle covering the lamellæ is formed of columnar cells, which at the anterior margin, where growth is most vigorous, are extremely long; removing this, there are seen on the ventral side of the last-formed septum, especially at the margin, developing sinuous partitions, over which I have been unable to demonstrate any such conchyolin membranes as are shown in Fig. 2. Further, this hypothesis requires subsequent growth of the septum as well as of the wall.

In the adult *Nautilus*, *Ammonites*, and *Spirula* the last septum is always nearer the penultimate septum than the regular increase in the depth of the chambers would lead one to expect; this also obtains in *Belemnites* so far as our fragmentary specimens allow one to judge, and, as Riefstahl has shown, in Sepia. The Intussusception-hypothesis demands (i) that this should be also the case in the young; (ii) that, in any one species, the body-chamber should at all ages be of the same depth in proportion to the length of the whorl. Riefstahl and his reviewer in Naturforscher (April 30, 1887) assume these facts and adduce them as arguments. But in smaller and presumably younger specimens of *Sepia* the last-formed lamella does not always seem to be nearer the penultimate, while the spaces between the insertion-lines are regular: it is easy to be deceived by the fact that all the lamellæ approach one another at their posterior borders. In *Nautilus* sections through undoubtedly young shells show that the last-formed chamber is actually larger than the preceding. In such young shells a distinct nacreous ring often indicates the first formation of a fresh septum. Had it been completed, the chamber enclosed by this septum would, without any interstitial growth, have been of increased size: the ratio of the body-chamber to the whorl, as compared with other specimens, is less or greater according as this half-formed chamber is counted in or not. The evidence from *Ammonites* is often vitiated by fracture; granting that the last chamber in small specimens is sometimes of relatively little depth, it is not so always, and in adults there may be seen, though rarely, a small air-chamber between two of normal size. In *Nautili* the 8th chamber is always less deep than those preceding, for the increased breadth and height of the cone makes up for loss of depth: examination of shells with only 8 or 9 chambers would therefore be deceptive. Riefstahl says that his fixed point is the hinder end of the animal's body: this does not explain the lines of advance so clearly seen in the muscle-scars.

So far facts do not confirm the Intussusception-hypothesis, some of those here brought forward favour the old view. Still Dr. Riefstahl deserves our gratitude for re-opening an interesting question, which is not likely to be settled without further investigation.[1]

[1] As bearing upon the subject of this Article, see a paper "On the Structure of Camerated Shells" by Henry Woodward, Popular Science Review, 1872, vol. xi. pp. 113–120, pl. lxxxii.

IV.—Further Notes on the Tertiary Entomostraca of England, with Special Reference to those from the London Clay.

By Professor T. Rupert Jones, F.R.S., and C. Davies Sherborn, F.G.S.[1]

(*Continued from p.* 392.)

28. Cythere costellata (Roemer), var. triangulata, nov.

The specimen under notice is relatively shorter, broader (higher), more triangular, and with sharper ridges than the figure in the 'Monograph,' 1856, pl. vii. f. 21. The anterior hinge is more prominent, and the front margin rather oblique. It is also narrower behind, ending with three small spines or denticles. The edge view is acute-ovate. From the Belosepia-bed, Bracklesham. T. R. Jones' Collection.

This variety of *C. costellata* is figured and described in the 'Monogr. Post-Tert. Entom.' 1874, p. 152, pl. xvi. figs. 13-15, from Selsey, and there recognized as being probably of Tertiary date, though found in the superficial mud.

29. Cythere plicata, Münster.

We have a narrow and compressed carapace, contracted posteriorly, from the Belosepia-bed, Bracklesham. T. R. Jones's Collection. This species is noticed in the Geol. Mag. 1874, p. 479, as having been found in the London Clay of Copenhagen Fields, with two species of *Chara*.

30. Cythere latimarginata, Speyer.

Cythere latimarginata, Speyer, Tert. Ostrac. Casell., 1863, p. 22, pl. iii. fig. 3.
Cythere abyssicola, G. O. Sars, Overs. Norg. Mar. Ostrac., 1865, p. 163.
Cythere latimarginata, Brady, Crosskey, and Robertson, Monogr. Post-Tert. Entom., 1874, p. 163, pl. xvi. fig. 6.
Cythere latimarginata, G. S. Brady, Trans. Zool. Soc., vol. x. p. 389, pl. lxiv. fig. 8.

Following Dr. Brady's determination of this species in the papers above mentioned, we refer this specimen to Speyer's species. The figure in the "Monogr. Post-Tert. Entom." comes nearest to our form, but is furthest from Speyer's original figure, to which the figures of the Antwerp-Crag specimens in 'Trans. Zool. Soc.' nearly approximate.

One valve; White (Coralline) Crag. T. R. Jones's Collection.

31. Cythere angulatopora (Reuss).

Cypridina angulatopora, Reuss, Haidinger's Nat. Abth. vol. iii. 1854, p. 86, pl. x. fig. 32.

An oblong valve, with parallel dorsal and ventral margins, and rounded ends. Surface with numerous small, more or less angular pits, arranged in parallel rows. A series of pits independently of the other ornament, follows the semicircular outline of the anterior end, just within the margin. The hinder margin is toothed. A single valve, associated with *Nummulites elegans*, in a bed regarded as at the top of the Bracklesham series, Hunting Bridge, New Forest. Collected by Mr. Keeping. T. R. Jones' Collection.

[1] For Plate XI. see September Number Geol. Mag. facing p. 385.

The specimens figured and described as *C. angulatopora*, in the "Monogr. Tert. Entom.," 1856, p. 34, are not referable to that species. Figs. 17 and 18 of plate iv. correspond with the form (No. 33) to which we have here given the name *C. scalaris*; and fig. 18, pl. vi. figured by Bosquet (we think, erroneously) as *C. angulatopora* of Reuss, we now regard also as a new species, and have named it C. Bosquetiana (No. 32).

32. Cythere Bosquetiana, sp. nov.

Cythere angulatopora (not Reuss), Bosquet, Entom. Tert. 1852, p. 68, pl. iii. fig. 5.
Cythere angulatopora (not Reuss), Jones, Monogr. Tert. Entom., 1856, p. 34, pl. vi. fig. 18.

One of the oblong species of *Cythere*, with rounded ends, well-marked hinges, and convex valves, ornamented with a strong reticulation, the longitudinal meshes of which are stronger than the transverse. Just in front of the centre of the valve the meshes show an inclination to assume a concentric arrangement. This is strongly marked in fig. 18, pl. vi. of the Monogr. 1856.

One valve, occurring with *Nummulites elegans*, in the "uppermost bed" of the Bracklesham Series, at Hunting Bridge, New Forest. Collected by Mr. Keeping. T. R. Jones' Coll.

33. Cythere scalaris, sp. nov. Pl. XI. fig. 7.

Cythere angulatopora (not Reuss), Jones, Monogr. Tert. Entom., 1856, p. 34, pl. iv. figs. 17, 18.

Another oblong *Cythere* with nearly equal ends, but the front margin, sloping to the strongly marked anterior hinge, is more oblique than the other. The surface has longitudinal ridges, which on the hinder moiety of the valve are connected by transverse riblets, making irregular square meshes. The disposition of the ridges vary as to their parallelism.

A fine series of allied forms, from Gaas, near Dax, have been described and figured by Reuss ('Sitz. k. Ak. Wiss. Wien,' vol. lvii. 1868, pp. 38–40, pl. vi. figs. 3, 4, 5, and 7); but the differences are sufficiently apparent.

Two or three examples, London Clay; Islington. T. R. Jones' Coll.

34. Cythere polyptycha (Reuss), var.

Somewhat trigonal-obovate; the antero-ventral angle and the opposite hinge both well developed. Anterior border nearly semicircular; the posterior somewhat contracted. Surface puckered with nearly parallel, but irregular, longitudinal ridges, with intermediate rough, but obscure reticulation. The central region swollen into a round boss. Except that this specimen is less quadrate, possesses a boss, and is less distinctly reticulate, it closely resembles Reuss' original figure, Haidinger's 'Nat. Abth.,' vol. iii. 1854, p. 83, pl. x. fig. 22, from the Tertiary of Bohemia.

This *Cythere* belongs to a group of which *C. pusilla*, Bosquet, Entom. Tert., p. 85, pl. iv. fig, 7, may be taken as a type; possibly embracing the species referred by G. S. Brady, Trans. Zool. Soc., vol. v. 1866, p. 376, pl. lix. fig. 10, to Reuss' *C. clathrata* (which

does not appear to us to be at all identical), and also *C. pumila*, G. S. B., *op. cit.*, p. 378, pl. lx. fig. 7. The latter, though near to our specimen, has far more irregular ridges.

One valve, from the "Norwich Crag" of Southwold. T. R. Jones' Collection.

35. Cythere scrobiculo-plicata, Jones. Pl. XI. Fig. 8.

A figure of this species is reproduced from "Monograph Tert. Entom.," 1856 (p. 33, pl. vi. figs. 4 and 6), as one of the forms belonging to the London Clay of Finchley and Copenhagen Fields; the species also belongs to the Barton Clay, in which deposit it occurs in greater abundance than in the London Clay.

36. Cythere Harrisiana, Jones. Woodcut Fig. 1.

Cythereis interrupta, Jones. Monogr. Cretac. Entom., 1849, p. 16, pl. ii. f. 6.
Cythere Harrisiana, Jones. Geol. Mag., 1870, pp. 75, 76.

This form was found with *C. spinosissima*, hereafter described, while looking over for a second time some washings of London Clay. We have only this one valve, which agrees so closely in every particular with valves from the Gault, presenting the same isolated prickles and the pursed-up posterior end with its flattened margin, that we cannot separate them.

Fig. 1.—*Cythere Harrisiana*, Jones.

Sherborn and Chapman Collection; from Piccadilly, London.

37. Cythere Forbesii, sp. nov.

A subquadrate form, approaching the more definitely squared *Cytheræ*, for which we conveniently keep the subgeneric name of *Cythereis*. The valves are well-rounded in front and behind, with nearly straight lower and upper margins, the latter marked with well-defined hinges. The posterior margin is usually denticulate. The surface bears 6 or 7 crenulate and fenestrate ridges; those on the ventral region being more continuous than those on the dorsal. The interspaces of the ridges are deeply reticulated. This distinct and well-defined species we dedicate to the late Edward Forbes, whose investigations into the fossil fauna of the Isle of Wight Tertiaries will ever be gratefully remembered.

Specimens numerous, from the Fluvio-marine beds of Headon, Isle of Wight. F. Edwards' Collection in the British Museum.

38. Cythereis Bowerbankiana, Jones. Pl. XI. Fig. 9.

Monogr. Tert. Entom. 1856, p. 38, pl. vi. figs. 7 and 8.

A figure of this quadrate species, characteristic of the London Clay, is here reproduced in illustration of the group. It has been found at Copenhagen Fields and Wimbledon Common (Jones), and at Whitecliff Bay (Sherborn).

39. Cythereis spinossissima, sp. nov. Woodcut, Fig. 2.

A right and left valve of this form were lately found, with *C. Harrisiana*, in some washings of the London Clay from Piccadilly. They are oblong, with the front margin broader and more semi-

circular than the hinder. Surface coarsely reticulate; the reticulations becoming more shallow and indistinct as they reach the central area. Many of the ridges of the meshes are pinched up at their junctions, and in most cases thus form bluntly-pointed spines; these spinous prolongations are partly the cause of the confusion of the reticulation in the central area. Approaching the margins, the spines become longer and more defined; and the anterior area bears, in addition to its marginal row of spines, a second row just within the other. In this form, related to *C. Bowerbankiana*, on the one hand, and to *C. horrescens* on the other, we note that the characteristic ventral ridge of spines, which is present in both these forms, is absent, being merely represented by scattered spines, not arranged in a definite order except on the anterior area. The reticulation is also much more distinct,—a marked feature in the new form.

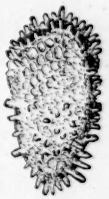

Fig. 2.—*Cythereis spinossissima*, sp. nov.

To this same group belongs a rather common recent and Post-Tertiary species, namely, *Cythereis Dunelmensis*, Norman (the references are given in full in the "Monogr. Post-Tert. Entom." 1874, p. 168). The chief differences between this and the older form from the London Clay are in the shape of the posterior margin, which is elliptically rounded in the latter instead of being square, and a more definitely spinose, instead of foliaceous, condition of the ornament, especially towards the margins.

Two valves only: from Piccadilly. Sherborn and Chapman Collection.

40. Cythereis aranea, sp. nov. Pl. XI. Fig. 10*a*, 10*b*.

Oblong, with the front margin broader and rounder than the hinder, both more or less denticulate. The surface ornamented with a delicate raised network of irregular meshes, which extend over the flat ventral area. Two ridges, over which the network is traceable, are present. One, shorter than the other, occupies the median line from about the centre to the edge of the posterior slope, which makes a strong depression at the hind margin. The other and longer ridge commences in a curve inside the front margin, rises as it borders the ventral region, and dies out at the posterior slope, like the other. The ventral aspect of the carapace is cuneiform or almost sagittate. *C. Haidingeri*, Bosquet, 'Tert. Entom.,' p. 125, pl. vi. fig. 10, is near to this species in general characters; but its more angular shape, and more symmetrical network distinguish it. So also *C. Edwardsii* (Roemer), Reuss, 'Haidinger's Nat. Abth.' vol. iii. p. 84, pl. x. fig. 24, is like it to some extent; but its ridges extend the whole length of the valve, joining fore and aft, and, as figured by Bosquet, 'Entom. Tert.' p. 94, pl. iv. fig. 14, it appears still coarser or stronger, and with still more marked features.

Several specimens from the London Clay; Piccadilly, London. Sherborn and Chapman Collection.

41. Cythereis Prestwichiana, sp. nov. Pl. XI. Figs. 11*a*, 11*b*.

A very small neat *Cythereis*, with well-developed marginal rim in front, which, passing along the ventral region, gradually rises higher, and ends in a sharp rectangle. A similar, but lower, ridge follows the dorsal edge. Both are more or less crenulated. There is a central boss, and a short ridge behind it, ending, like the others, at the sudden posterior slope, which terminates in a narrow, produced, flat, and toothed edge. The surface of the valve is somewhat depressed, and is covered with a distinct lace-like reticulation. Edge-view, subsagittate.

This form is clearly related to that figured in the "Monogr. Cretaceous Entom.," 1849, pl. v. fig. 13*b*., which we propose to remove from *C. ornatissima* (Geol. Mag., 1870, p. 75). We now have closely allied forms from the Chalk of other localities of the British Islands, and the distinctness of this new species, named after Prof. Prestwich, becomes more and more apparent.

Two valves from the London Clay of Whitecliff Bay, Isle of Wight. Collected by C. D. Sherborn.

42. Cythereis Hoernesi, Speyer.

Cytherella Hoernesi, Speyer. Ostrac. Cassel. Tertiär., 1863, p. 32, pl. iii. fig. 7; pl. iv. fig. 1.

Oblong; swollen into a distinct boss in the centre; ends round, the front margin semicircular and deeply fenestrated, the hind margin depressed and slightly toothed. Surface reticulated, ornamented with two prominent ridges, the dorsal and most striking of which, strong, fenestrated, and somewhat convex, partly obscures the hinge-line, and curves forwards and downwards below the front hinge. The ventral ridge is not so strong; both are sharply angular posteriorly.

The only marked difference between our specimen and that figured by Dr. Speyer is—that the dorsal ridge in the former is much better developed, being higher, thinner, fenestrate, more delicate, and ending posteriorly in a much sharper angle.

A single valve from the White (Coralline) Crag. T. R. Jones' Collection.

43. Cythereis corrugata (Reuss), var.

This valve is rugosely reticulate, with the longitudinal meshes stronger and more persistent than the transverse. Several allies of this form are figured in plates xxi. and xxii. of the "Report Challenger Ostracod.," 1880. Of the previously published forms we find that *C. corrugata*, Reuss, Haidinger's Nat. Abth. vol. iii. p. 79, pl. x. fig. 14, is the nearest to ours, although it varies in being squarer, stronger, swollen at centre, and strongly rimmed on the front margin.

One specimen, collected by the late F. Edwards from the Fluvio-marine beds, Headon, Isle of Wight. British Museum.

44. Cythereis cornuta (Roemer).

Three or four specimens of this form from Bracklesham, of which

one is here figured, differ individually from those previously figured in the Monogr. 1856, and elsewhere, in their narrowness, the parallelism of their upper and lower margins, and in the replacement of the curved dorsal ridge by a uniform marginal rim. The very faint markings seen along the ventral ridge, in the figures in the Monograph of 1856, are more distinct in the specimens now under consideration, and are evidently due to alternate thick and thin rod-like divisions, forming minute, light and dark, squarish areas. The slight transverse dorsal notch in fig. 19 is also traceable in our present specimens, when carefully illuminated and strongly magnified.

Bracklesham. T. R. Jones' Collection.

45. Cytheridea perforata (Roemer).

This specimen is like figure 14*a*, pl. iv. in the 'Monogr.' 1856, but is rather less triangular, much more coarsely punctate and strongly marked at the front hinge.

It was found with numerous normal valves in some washings from the clay at Barton.

T. R. Jones' Collection.

46. Cytheridea perforata, var. insignis. Pl. XI. Fig. 12.

Monogr. Tert. Entom., 1856, p. 46, pl. vi. fig. 3.

This fine variety is reproduced in the accompanying Plate from the original monograph. It was found in the London Clay of Copenhagen Fields.

47. Cytheridea glabra, Jones. Pl. XI. Fig. 13.

Cytheridea perforata, var. *glabra*, Jones. Monogr. Tert. Entom., 1856, p. 46, pl. v. fig. 24.

This angular and smooth form, related to *C. perforata*, should now, we think, be regarded as a species. It came from the London Clay of Copenhagen Fields.

48. Cytheridea punctillata, Brady.

One damaged valve we refer to this species, which has been described and figured in full in the 'Monogr. Post-Tertiary Entom.,' 1874, p. 177, pl. vi. figs. 1–11. Our specimen, however, approaches most closely to another figure of the same species in Dr. G. S. Brady's paper, 'Trans. Linn. Soc.,' vol. xxvi. (1868), p. 424, pl. xxvi. fig. 36.

From the "Norwich Crag" at Southwold. T. R. Jones' Collection.

49. Cytheridea pinguis, Jones.

We have this species from the Weybourn Crag; collected by Mr. Clement Reid at East Runton. Dr. G. S. Brady figures it from the Antwerp Crag, 'Trans. Zool. Soc.,' vol. x. p. 397, pl. lxii. fig. 3.

50. Cytheridea debilis, Jones.

We have seen a right valve (opposite to that figured in the Monograph, 1856), apparently belonging to this species from the Belosepia-Bed, Bracklesham. Science Schools Collection.

51. Cytheridea elongata, Brady.

C. elongata, G. S. Brady. Monogr. Recent Brit. Ostrac., Trans. Linn. Soc. 1868, vol. xxvi. p. 421, pl. xxviii. figs. 13–16; pl. xl. fig. 6; Monogr. Post-Tert. Entom., 1874, p. 181, pl. ix. figs. 10–13.

Numerous specimens from the Weybourn Crag of East Runton, varying slightly in individuality of growth and sex, are referable to Brady's *Cytheridea elongata*. Collected by Mr. Clement Reid, F.G.S. We have it also, not rare, in the Crag of Southwold (Norwich Crag).

52. Krithe glacialis, B. C. and R. Pl. XI. Fig. 15*a*, 15*b*.

B. C. and R. 'Monogr. Post-Tertiary Entom.,' Pal. Soc., 1874, p. 184, pl. vi. figs. 21–24.

A smooth specimen of *Krithe* from the London Clay of Piccadilly is so extremely close in every feature to *K. glacialis* from Scotland and Norway, except in the apparent pitting of the latter, that we cannot separate it from this later form. Sherborn and Chapman Coll.

53. Krithe Londinensis, sp. nov. Pl. XI. Fig. 14*a*, 14*b*.

Carapace narrow obovate, not quite semicircular in front, subacute posteriorly. In edge-view the anterior third is compressed and wedge-shaped, the middle is swollen, and the posterior third is compressed, and ends in the usual notch formed by the produced ends of the two valves. Surface smooth and shining. In this last feature it resembles other forms of this genus, but in its outlines it differs from any we know. From the London Clay of Piccadilly. Sherborn and Chapman Collection. Bornemann's *Bairdia pernoides* (Zeitschr. D. g. Ges. vol. vii. 1855, p. 358, pl. 20, fig. 7) is a somewhat similar *Krithe* of this geological age.

54. Xestoleberis aurantia (Baird), 1835; var.

Xestoleberis aurantia, Brady, Crosskey and Robertson, 'Monogr. Post-Tert. Entom.,' Pal. Soc. 1874, p. 191, pl. xvi. figs. 32, 33. (Full synonymy is here given.)

Except in being minutely punctate, and not distinctly papillose, this specimen (from Headon) closely resembles the recent *X. aurantia*, above quoted. From the Fluvio-marine deposits of Headon Hill, Isle of Wight. Collected by the late F. E. Edwards, and now in the British Museum.

55, Xestoleberis Colwellensis, sp. nov.

Carapace ovate in outline, and subovate in edge-view, with spinulose surface. This is near *X. aurantia* (Baird), but blunter anteriorly.

From the Tertiary of Colwell Bay. T. R. Jones' Collection.

56. Cytherura Prestwichiana, sp. nov.

This belongs to the same type as *Cytherura nigrescens*, B. C. and R., 'Post-Tert. Entom.,' p. 192, pl. xi. f. 28–32, but differs in its greater compression anteriorly, and in being less strongly notched behind. Allied forms are known to us from several Jurassic strata. From the Belosepia-bed, Bracklesham. T. Rupert Jones's Collection.

Named after Professor Prestwich, of Oxford, who has so greatly advanced our knowledge of the Tertiary deposits.

57. Cytherura clathrata, G. O. Sars.

Cytherura clathrata, G. O. Sars. Brady, Trans. Linn. Soc., vol. xxvi. 1868, p. 446, pl. xxix. figs. 43-46; B. C. and R., Post-Tert. Entom., Pal. Soc. 1874, p. 204, pl. xi. figs. 1-4.

In this small and interesting form, the oval carapace is somewhat sharper behind than before, and more compressed in front than behind. It has the surface ornamented with a strong median ridge, branching freely off towards the margin. The main branches in our specimen keep their entirety, but Dr. G. S. Brady figures individuals in which the branches lose themselves in a rough general reticulation over the surface. From the Weybourn Crag of East Runton; collected by Mr. Clement Reid, F.G.S.

58. Cytheropteron triangulare (Reuss). Pl. XI. Fig. 16.

Cythere triangularis, Reuss, Zeitschr. Deutsch. geol. Ges. vol. vii. 1855, p. 279, pl. x. fig. 3.
" " Jones, Monogr. Tert. Entom. 1856, p. 25, pl. vii. fig. 5.
" *tenuicristata*, Reuss, Sitzungsb. k. Ak. Wiss. Wien, vol. lii. 1865, p. [23] plate, fig. 12.

This well-marked form has already been well described, as also have several allies, namely, *Cytheropteron mucronalatum*, Brady, "Challenger," 1880, p. 140, pl. xxxiii. fig. 8; *C. fenestratum*, Brady, *Ibid.* p. 139, pl. xxxiv. fig. 6; and *C. sphenoides* (Reuss), Denkschr. k. Ak. Wiss. Wien, vol. vii. p. 141, pl. xxvii. fig. 2.

From the London Clay of Piccadilly; Sherborn and Chapman Coll.

59. Cytherideis gracilis (Reuss).

Cytherina gracilis, Reuss, Haidinger's Nat. Abh. vol. iii. 1850, p. 52, pl. liii. fig. 3.
Cytherideis gracilis, Brady, Trans. Zool. Soc., vol. v. 1866, p. 367, pl. lviii. f. 1*a–d*.

To this neat form, already described by Reuss and others, the following are more or less allied:—*C. arcuata* (Bosq.), Tert. Entom., 1852, p. 32, pl. i. fig. 14; *C. lithodomoides* (Bosq.), *Ibid.*, p. 36, pl. ii. fig. 3; *C. Bairdia difficilis* (Reuss), Sitzungsb. k. Ak. Wiss. Wien, vol. lvii. 1868, p. 35, pl. v. fig. 7.

The figure given in the "Fonds de la Mer" (8vo. Paris, 1867–71), livr. 4, 1868, p. 94, pl. xii. figs. 1, 2, of Brady's *Aglaia pulchella* reminds us of this form.

We have one small specimen from a Tertiary bed at Colwell Bay. In the closed carapace the right valve is the smallest; it is faintly toothed on the anterior margin. The longitudinal lines on the ventral surface are distinct, though faint.

Cytherella, Jones (sub-genus), 1849.

The members of this genus are separable with difficulty as to their probable specific identities (Monogr. Carbonif. Entom., Part I. No. 2, Pal. Soc., 1884, pp. 57-69). For the recognition of the Tertiary forms, with which we are at present concerned, we propose to keep certain types in view, referring our specimens to one or the other of the several groups.

Group I.—Typified by *Cytherella compressa* (Münster), as figured by Egger, 'Ostrak. Ortenburg,' Neues Jahrb., 1858, p. 404, pl. ii. fig. 2, with its wedge-like ends and flat parallel sides. To this we

must relegate *C. Londiniensis*, Jones, 'Monogr. Tert. Entom.' p. 54, pl. v. figs. 20 [reproduced here, Pl. XI. Fig. 19] and 22, besides, "*C. compressa*, var. 2," Fig. 19 of the same Plate.

Group II. *Cytherella Muensteri* (Roemer). These carapaces have their greatest convexity near the middle or towards the hinder part of the valves. One of our specimens from Bracklesham belongs to this group; but we know of none exactly like it, in its symmetrical, broad, and oblong outline, with nearly equally rounded ends, median convexity toward the ventral edge, and broadly ovate edge-view. We call it *C. Rœmeri*. Another is near Roemer's original figure, 'Neues Jahrbuch, für Min. etc.' 1838, p. 516, pl. vi. fig. 13, in shape, though not so strongly punctate. In the 'Monogr. Tert. Entom.,' p. 56, pl. v. fig. 13, is a smooth variety; but fig. 12 is even more strongly pitted than is Roemer's fig. 13, and was termed var. *rectipunctata* in the Geol. Mag., 1870, p. 157. Some allied forms, smooth and having the convexity more definitely in the hinder third of the valves, are remarkably ovate in outline, and lanceolate in edge-view. These may be regarded as belonging to a new species to be called *C. Reussii*, after the eminent micrologist of Prague and Vienna. In the 'Monogr. Tert. Entom.,' p. 54, pl. v. figs. 21 [reproduced in our Pl. XI. Fig. 17] and 23 are also smooth, and belong to this group: but they are obovate in outline, like Bornemann's *C. fabacea*, 'Zeitschr. Deutsch. geol. Ges.,' vol. vii. 1855, p. 355, pl. xx. fig. 2, to which they must be referred, as in Geol. Mag. 1870, p. 157. Another of our Tertiary *Cytherellæ* is ovate-oblong, lanceolate in edge view, with acute-ovate end-view. This also we believe to be new, and name it *C. Dixoni*, in memory of one of the most enthusiastic workers on the geology and fossils of Bracklesham, whence all but one of the *Cytherellæ* described as new in this paper have been obtained.

A very small *Cytherella*, smooth, subovate, and with lanceolate edge-view, belongs apparently to Group II. It was found by Mr. Clement Reid in the Weybourn Crag of East Runton.

Group III. The type is *Cytherella Beyrichi* (Reuss).

Cytherina Beyrichi, Reuss, Zeitschr. Deutsch. geol. Ges., vol. iii. 1851, p. 89, pl. vii. fig. 65.

Cytherella Beyrichi, Bornemann. *Ibid.* vii. 1855, p. 354, pl. xx. fig. 1.

,, *compressa*, var. 1, Jones. Monogr. Tert. Entom. 1856, p. 55, pl. v. fig. 18. [Reproduced here, Pl. XI. Fig. 18.]

,, *Beyrichi*, Speyer, Ostrac. Cassell. Tertiär., 1863, p. 54, pl. i. fig. 1.

,, *Beyrichi*, Brady, Trans. Zool. Soc., vol. v. 1866, p. 362, pl. lvii. fig. 3.

,, ,, Jones, Geol. Mag. 1870, Vol. VII. p. 157.

In this group the carapaces vary from round-ended oblong to ovate-oblong, with a partial flattening of the anterior portion, giving a compressed wedge-shaped edge-view. In most cases the posterior end is full and truncate, herein also differing from the members of Group II. Generally the surface is pitted, but we have a smooth example of this form. The last may be termed *C. Beyrichi*, var. *lævis*; but we consider that the others do not offer differences sufficient to separate them from the type as named varieties.

Referring especially to the specimens from the London Clay, we conclude that they should stand as follows:—

60. CYTHERELLA FABACEA, Bornemann. Pl. XI. Fig. 17.

Cytherella compressa, Jones (not Münster), Monogr. Tert. Entom. p. 54, pl. 5, fig. 21.

61. CYTHERELLA BEYRICHI, Bornem. Pl. XI. Fig. 18.

Cytherella Beyrichi (?), Jones, Monogr. Tert. Entom. p. 55, pl. v. fig. 18.

62. CYTHERELLA COMPRESSA (Münster). Pl. XI. Fig. 19.

Cytherella Londiniensis, Jones, Mon. Tert. Entom. p. 55, pl. v. fig. 20.
C. compressa, var. 2, Jones, *ibid.* fig. 19.

The last is very near to the other, but is rather more oblong and is somewhat punctate.

63. In Mr. Clement Reid's Collection we have seen the following Freshwater Ostracoda from the uppermost Pliocene Formations.

MUNDESLEY UNIO-BED.[1]

Cypris reptans (Baird).
,, *gibba*, Ramdohr.
Candona candida (Müller).
Cypridopsis obesa, B. & R.
Darwinula Stevensoni, B. & R.
Cythere concinna, Jones, var.

SIDESTRAND UNIO-BED.

Cypris reptans (Baird).
,, *Browniana* (?), Jones.[2]
,, *gibba*, Ramdohr.
Candona candida (Müller).
Cypridopsis obesa, B. & R.

64. Mr. C. Reid, F.G.S., has lately sent from the Isle of Wight:—

1. *Candona Forbesii*, Jones, from the Hempstead beds of Parkhurst Forest (Bore-hole, No. 32).

2. *Cytheridea Muelleri* and its variety, *torosa*, Jones; from Bore-hole No. 5, east bank of the Medina, one mile north of Newport.

65. In his notice of some of the Post-Tertiary deposits, associated with the Raised Beach at Portland (see Q.J.G.S. vol. xxxi. 1875, p. 39) Prof. Prestwich mentions two species (*Cypris Browniana* and *Candona candida*) as occurring there. We can now add *Cypris gibba*, Ramd., and *C. incongruens*, Ramd., besides an undetermined species.

66. We here add a list of some Post-Tertiary Entomostraca, which we find in a Chara-deposit from near Hitchin.

Collection of W. Hill, Esq., jun., F.G.S.

Cypris Browniana, Jones.
,, *incongruens*, Ramdohr.
Cypris reptans (Baird).
Candona candida (Müller).

The following are Lists of the species of Ostracoda treated of in the foregoing Memoir:—

WEYBOURN CRAG.

3. *Potamocypris trigonalis*, Jones, and var. *lævis*, nov.
14. *Cythere Reidii*, sp. nov.
15. ,, *retifastigiata*, Jones.
18. ,, *angulata*, Sars, var.
19. ,, *Charlesworthiana*, sp. nov.
20. *Cythere villosa*, Sars.
22. ,, *Woodwardiana*, sp. nov.
49. *Cytheridea pinguis*, Jones.
51. ,, *elongata*, Brady.
57. *Cytherura clathrata*, Sars.
Cytherella, sp.

[1] See also Trans. Norf. Norw. Nat. Soc. vol. iii. p. 631.

[2] Dr. G. S. Brady informs us that he has lately received *C. Browniana* from Loch Fadd, near Rothesay, and that it will be described and figured in a forthcoming Report of the Scottish Fisheries Commission.

Southwold Crag.

12. *Cythere recurata*, sp. nov.
20. ,, *villosa*, Sars.
34. ,, *polyptycha*, Rss., var. nov.
48. *Cytheridea punctillata*, Brady.
51. ,, *elongata*, Brady.

Bramerton Crag.

4. *Aglaia ? cypridioides*, sp. nov.
16. *Cythere lacrymalis*, sp. nov.
18. *Cythere angulata*, Sars, var.
21. ,, *læsa*, sp. nov.

Suffolk Crag.

10. *Bairdia rhomboidea*, sp. nov.
17. *Cythere dictyosigma*, Jones.
30. *Cythere latimarginata*, Speyer.
42. *Cythereis Hoernesi*, Speyer.

Hempstead, Isle of Wight.

1. *Cypridea spinigera* (Sow.).

Headon Hill, Isle of Wight.

27. *Cythere delirata*, sp. nov.
37. ,, *Forbesii*, sp. nov.
43. *Cythere corrugata*, Rss., var.
54. *Xestoleberis aurantia* (Baird).

Colwell Bay.

6. *Pontocypris* (?) sp.
55. *Xestoleberis Colwellensis*, sp. nov.
59. *Cytherideis gracilis* (Reuss).

Hunting Bridge.

31. *Cythere angulatopora* (Rss.).
32. *Cythere Bosquetiana*, sp. nov.

Barton.

45. *Cytheridea perforata* (Roemer).

Bracklesham.

5. *Bythocypris subreniformis*, sp. nov.
7. *Bairdia subdeltoidea* (Münster).
13. *Cythere venustula*, sp. nov.
26. ,, *gyriplicata*, sp. nov.
28. ,, *costellata*, Roem., var. *triangulata*, nov.
29. ,, *plicata*, Münst.
44. *Cythereis cornuta* (Roem.)
50. *Cytheridea debilis*, Jones.
56. *Cytherura Prestwichiana*, sp. nov.
Cytherella Muensteri (Roem.).
,, *Beyrichi* (Rss.) var. *lævis*, n.
,, ,, 3 varr.
,, *Rœmeri*, sp. nov.
,, *Reussii*, sp. nov.
,, *Dixoni*, sp. nov.

London Clay. (Figured and described in this paper.)

8. *Bairdia subtrigona*, Bornem.
9. ,, *Londinensis*, sp. nov.
11. ,, *ovoidea*, sp. nov.
23. *Cythere arenosa*, Bosq.
24. ,, *scabropapulosa*, Jones.
25. ,, ,, var. *aculeata*, nov.
33. ,, *scalaris*, sp. nov.
35. ,, *scrobiculoplicata*, Jones.
36. ,, *Harrisiana*, Jones.
38. *Cythereis Bowerbankiana*, Jones.
39. ,, *spinosissima*, sp. nov.
40. *Cythereis aranea*, sp. nov.
41. ,, *Prestwichiana*, sp. nov.
46. *Cytheridea perforata* (Roem.), var. *insignis*, Jones.
47. ,, *glabra*, Jones.
52. *Krithe glacialis*, B. C. & R.
53. ,, *Londiniensis*, sp. nov.
58. *Cytheropteron triangulare* (Rss.)
60. *Cytherella fabacea*. Bornem.
61. ,, *Beyrichi* (Rss.)
62. ,, *compressa* (Münster).

Appendix.—It is advisable to make the following emendations in the paper in the Geol. Mag. 1870:—Page 155, *for* No. 9 *read* No. 19, *and transfer the paragraph* to p. 156. Pages 157 and 159 for *Ilyobates* read *Krithe*. Page 158, 2* var. *tumida*, should come under 2 *Cypris Browniana*.

For later alterations in generic and specific names, see the present paper.

V.—The Gneissose Rocks of the Himalaya.

By R. D. Oldham, A.R.S.M., F.G.S.,
of the Geological Survey of India.

IT had not been my intention to publish anything on this subject at present, as I have in preparation a review of the present state of our knowledge of Himalayan geology; but as Col. McMahon has started the subject, and his paper is not exhaustive, I trust the following outline of that part which relates to the gneissose rocks may prove of interest.

The gneissose or granitoid rocks of the Himalayas may be divided into three groups:—

(1) The fundamental or "Central" gneiss of Dr. Stoliczka.
(2) The orthoclase, usually porphyritic and gneissose, granites.
(3) The oligoclase granite.

The last of these appears to be distinct from and of later date than the first two, and will not be further referred to here.

The fundamental, or, to use the term under which it was first described, the central, gneiss consists of a great thickness of crystalline rocks. In the little disturbed sections of the Upper Pábar Valley in Bissahir it is seen to unconformably underlie rocks which I have little doubt are the equivalents of Dr. Stoliczka's Babeh series of Silurian age. Both by lithological structure and mode of occurrence, these beds are shown to be of metamorphic, as opposed to intrusive origin; they contain beds varying from almost pure felspar to almost pure quartzite or mica-schist, but felspar is seldom altogether absent; some of the beds are *augen gneiss*, the eyes being lenticular in form, lying in accord with the planes of foliation, and, as regards their internal structure, consisting of a single twinned crystal of orthoclase.

On the section over the Babeh Pass, that first examined by Dr. Stoliczka, the beds are more disturbed and more metamorphosed. Highly foliated beds are rare, and the rock is for the most part a more or less fine-grained granitoid gneiss: some beds are *augen gneiss*, in which the eyes still maintain their lenticular form, though, as a rule, they have more or less acquired an outline in conformity with their crystalline structure; these crystals, however, still lie along the planes of foliation or very slightly oblique to them.

There can be little doubt that it is from the fusion of these beds that the gneissose granite was derived. Typically this rock consists of a somewhat fine-grained, slightly-foliated matrix, through which porphyritic crystals of orthoclase are scattered; the crystals exhibiting no definite orientation, but being scattered about with their axes pointing in every direction, as described by Col. McMahon. It occurs in large intrusive masses, or in veins of various thickness, usually intruded parallel to the bedding planes; the former usually show very slight signs of foliation, except near their boundaries, while the latter are almost, if not quite, invariably distinctly foliated. As the veins are traced away from their parent masses, the larger crystals of felspar appear to be left behind, and the rock

gradually ceases to be porphyritic, and sometimes contains merely a small proportion of felspathic material. How complete is the assumption of a gneissose and loss of the granitic structure may be judged from the fact that specimens from one exposure, which can be shown to be intrusive, have been examined by Col. McMahon, and declared by him to be a true gneiss showing no signs of intrusive origin.[1]

Col. McMahon has shown that the microscopic structure of this rock, as well as the inclusions of mica-schist, prove its intrusive nature. I may add that the same is shown by its mode of occurrence, by the manner in which it cuts across the bedding of the rocks among which it occurs, and by the invariable occurrence of contact metamorphism in the neighbourhood of any large mass of it. The intrusion, in many cases, does not seem either to have caused or been accompanied by any considerable disturbance, but to have taken place by a fusion (or solution) and absorption of the rocks which it has replaced. These often continue with a perfectly steady, low dip right up to a large mass of the gneissose granite, and end abruptly there; yet the intrusive nature of the granite is shown by the presence of included masses of these very rocks. The same thing is indicated by a study of the intrusive sheets; they constantly thin out and thicken without any disturbance of the bordering beds, which simply run up to the edge of the gneissose granite, and stop there abruptly; the granite itself too becomes more micaceous or more quartzose (according to the prevailing type of rock it has passed through) and less felspathic the further it is traced from its source, indicating a gradual increase of impurity. But the most conclusive proof I know of is exhibited by the sections on the eastern side of the Chor Mountain. The southern sections show a considerable thickness of volcanic beds, altered to more or less schistose hornblende rock; while on the northern sections these hornblende rocks are absent, but the granite has become so highly hornblendic that the ground-mass is of a dark green colour, throwing up the porphyritic crystals of white orthoclase in a most conspicuous manner.

Before passing on, it will be well to explain how these two distinct rocks came to be confused with each other. In the Sutlej Valley, between Simla and the Wangtu bridge, there are extensive exposures of gneissose rocks; these are almost all the gneissose granite, but owing to similarity of lithological appearance and absolute continuity of outcrop, they were (erroneously) confounded by Dr. Stoliczka with the granitoid gneiss which is exposed almost to the exclusion of intrusive granite on the ascent from the Wangtu bridge to the Bábeh pass. In 1877 Col. McMahon published a paper on the "Central gneiss" of the Simla Himalayas, in which he (correctly) identified the rock of the Chor and the gneissose granite intrusions south of the Sutlej with the rock of the Sutlej Valley. In 1883 he showed that while the rock of the Dhaoladhar, which he had identified with that of the Chor, could not in a single case be

[1] Rec. Geol. Surv. India, vol. xvii. p. 60; vol. xix. p. 86.

shown to be a true gneiss, it presented all the characters of an igneous rock. In this paper he dropped the term granitoid gneiss in favour of gneissose granite, and added that "it is for consideration whether the term 'central gneiss,' introduced by the late lamented Dr. Stoliczka, and since used to denote the 'granitoid gneiss' of the North-West Himalayas, should not be discontinued in future." Consideration is entirely in favour of this proposition, but against the total abandonment of the term "central gneiss," which may still be conveniently used for the fundamental gneiss, the oldest rock, in the Himalayas.

The separation of these two rocks in the field will often be a matter of difficulty, and not always possible, except where the gneissose or the intrusive characters are well developed; the microscope will not aid in this, for, as I have remarked above, in one case it has declared what can be shown to be an intrusive rock to be a metamorphic gneiss, while some of the more granitoid forms of the central gneiss show so little foliation and are so granitoid as seen in a hand specimen, that I doubt whether even microscopic examination would give a decided answer as to whether they are granite or gneiss. The general result then is the satisfactory one (for it is always more satisfactory to confirm than to refute a previous observer) that Dr. Stoliczka was correct in describing the oldest rock he observed as a *gneiss*, while Col. McMahon is equally correct in maintaining that the rocks of the Sutlej Valley and the Dhaoladhar are *granite*. I may now pass on to consider the cause of the foliation of this granite.

In considering this question, it is necessary to distinguish between the large, slightly foliated masses and the distinctly foliated sheets. In the former case the obscure foliation is probably in the main a form of fluxion structure, but the well-developed foliation of the thin sheets, which are occasionally sufficiently fissile to be used as flags or roofing slates, cannot be solely due to this cause.

When we find intrusive sheets of a few feet, or even a few tens of feet, in thickness, extending for miles without more than mere local variations of thickness, it must be evident that their fluidity cannot have been in any great degree due to excess of temperature; in the case of the thinner sheets I do not think that it can have been in any degree due to this cause, but rather to a difference of composition which enabled the granite to maintain some degree of fluidity, while the rocks into which it was intruded remained solid. Whatever this temperature may have been, it was sufficient to metamorphose the sedimentary beds which have always been converted into more or less perfect schists, that do not exhibit any marked increase of metamorphism near the sheets of gneissose granite intruded into them.[1]

[1] Contact metamorphism is only conspicuous in the case of large intrusive masses. The statement in the text may seem inconsistent with that of Col. McMahon regarding the slightly metamorphosed condition of the slates in contact with the outer band of gneissose granite in the Dalhousie region; but the particular slates referred to are everywhere characterized by a much greater power of resisting metamorphism than those above and below them. I have more than once observed the total absence of metamorphism, or the mere development of a micaceous glaze on the bedding-planes, where associated beds were converted into distinct schists.

The exact causes productive of foliation are not thoroughly understood, but it appears to be in some way related to the parallel structure due to stratification or cleavage, as the case may be. In the case of an intrusive sheet of granite, there would be neither stratification nor cleavage; but friction against the sides of the channel it flowed in would be sufficient to produce a slight parallel structure in a viscid mass; while it is not inconceivable that the very fact of the minerals, in the rock on either side, arranging themselves in a laminated structure, would induce similar rearrangement of the minerals in the gradually cooling granite. In short, I believe that the very slight foliation of the larger masses is principally a fluxion structure, while the more developed structure of the thinner bands, and near the margins of the larger masses, was produced in the solid but still heated granite by the same causes—whatever they be—that led to the foliation of the adjacent sedimentary beds.[1]

Before leaving this subject, there is one point that may be referred to with advantage. In Mr. Lydekker's memoir on the geology of Cashmir it is stated, both on the map and in the text, that part of the gneiss of that region consists of metamorphosed Silurian strata; this statement will not, I fear, be borne out by a more detailed examination of the ground. I have had a tolerably extensive, if fragmentary experience of the Himalayas, during which I have never seen a case of beds, which occur elsewhere as slates, having been converted into gneiss; but I have seen sections, similar to those described by Mr. Lydekker, where there appears to be a gradual passage from slate to gneiss. It appears not to be uncommon that near the boundary of a crystalline area there should be sections showing a considerable thickness of gneissic rocks, with small intercalations of non-gneissic beds, which can occasionally be recognized as belonging to some definite horizon in the slaty series. The sections, at first sight, seem to indicate an extreme metamorphism of the beds, a few of which have so far escaped metamorphism as still to be recognizable. Apart, however, from the fact that the gneiss exhibits those features especially characteristic of the gneissose granite, where I have been able to trace the horizontal extension of the rocks into unaltered slates, the change has not been by a gradual diminution in the metamorphism of the rocks as a whole, but by a gradual diminution of the gneissose beds, those which remain being as distinctly crystalline as before, till, where they have diminished in thickness and the schistose beds prevail, they can be distinctly recognized as intrusive gneissose granite. The sections indicate, not an extreme degree of metamorphism of the slaty rocks, but their more or less complete obliteration by gneissose granite.

In Western Garhwál there is a considerable development of arkose beds which have become foliated, but are still recognizable as foliated arkose. It is quite conceivable that similar beds might be so metamorphosed as to be undistinguishable from gneiss, but with this

[1] In 1884 Colonel McMahon seems to have held an opinion somewhat similar to this (see Records Geol. Surv. India, vol. xvii. p. 72), but so far as I can understand his paper in the May Number of this MAGAZINE, he has now abandoned it.

exception (which could not be called a true metamorphic gneiss as the felspar was provided ready made), I do not think that any beds belonging to the slaty series of the Himalaya have been converted into gneiss; whether they could be is a matter to be decided by chemical analysis.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science. Fifty-seventh Meeting, Manchester, 1887.

Section C.—Geology.

President: Henry Woodward, LL.D., F.R.S., F.G.S.

Titles of Papers Read September 1st to 7th, 1887.

1. Address by the President.
2. *Prof. W. Boyd Dawkins.*—On the Geography of the British Isles in the Carboniferous Period.
3. *Prof. W. Boyd Dawkins.*—On the Structure of the Millstone Grit of the Pennine Chain.
4. *Mark Stirrup.*—Foreign Boulders from Coal Seams.
5. *Dr. G. J. Hinde.*—On the Organic Origin of the Chert in the Carboniferous Limestone Series of Ireland, and its similarity to that in the corresponding strata of North Wales and Yorkshire.
6. *Robert Law and James Horsfall.*—On the Discovery of Carboniferous Fossils in a Conglomerate at Moughton Fell, near Settle, Yorkshire.
7. *Dr. H. Crosskey.*—Report on the Erratic Blocks of England, Wales, and Ireland.
8. *Prof. E. Hull.*—Note on a few of the many remarkable Boulder Stones to be found along the Eastern Margin of the Wicklow Mountains.
9. *Prof. H. Carvill Lewis.*—The Terminal Moraines of the great Glaciers of England.
10. *Prof. H. C. Lewis.*—On some important Extra-Morainic Lakes in England, North America, and elsewhere, during the period of Maximum Glaciation; and on the Origin of Extra-Morainic Boulder Clay.
11. *Hugh Miller.*—A comparative study of the Boulder Clay in the Glaciated Districts of Europe—Britain, Norway, Switzerland, Low Germany, and the Pyrences.
12. *Dr. H. Hicks.*—Report on the Cae Gwyn Cave, North Wales.
13. *J. W. Davis.*—On an Ancient Sea-Beach near Bridlington, containing Mammalian Remains.
14. *Dr. H. Woodward.*—On the Discovery of a Larval Cockroach, *Etoblattina Peachii* (H. Woodw.), from the Coal-Measures of Kilmaurs, Ayrshire.
15. *Dr. H. Woodward.*—On a new form of *Eurypterus* from the Lower Carboniferous Shales, Glencartholme, Eskdale, Scotland.

16. *Dr. H. Woodward.*—On a new Trilobite (*Conocoryphe*) from the Upper Green Slates, Penrhyn Quarry, near Bangor.
17. *Prof. T. Rupert Jones.*—Report on the Fossil Phyllopoda of the Palæozoic Rocks.
18. *Prof. H. G. Seeley.*—Evidence on the Mode of Development of the young of *Plesiosaurus*.
19. *Prof. H. G. Seeley.*—On the reputed Clavicles and Inter-Clavicles of *Iguanodon*.
20. *Prof. H. G. Seeley.*—On *Cumnoria*, an Iguanodont Genus founded on *Iguanodon Prestwichi*, Hulke.
21. *Prof. H. G. Seeley.*—The Classification of the Dinosauria.
22. *Prof. Vilanova.*—Sur la calcedoine enhydrique et la roche dans laquelle se trouve à Salto Oriental (Uruguay) avec exhibition de l'echantillon.
23. *Prof. W. Boyd Dawkins.*—On the Schists of the Isle of Man.
24. *Prof. G. A. Lebour.*—On Thinolite and Jarrowite.
25. *W. W. Watts.*—A Shropshire Picrite.
26. *Vaughan Cornish and Percy F. Kendall.*—On the Mineralogical Constitution of Calcareous Organisms.
27. *Sir J. William Dawson.*—On New Facts relating to *Eozoon Canadense*.
28. *Dr. T. Sterry Hunt.*—Gastaldi on Italian Geology and the Crystalline Rocks.
29. *Dr. T. Sterry Hunt.*—Elements of Primary Geology.
30. *Prof. T. G. Bonney.*—Preliminary Note on Traverses of the Western and of the Eastern Alps, made during the summer of 1887.
31. *J. E. Marr.*—Some effects of Pressure on the Sedimentary Rocks of North Devon.
32. *Prof. J. F. Blake.*—Report on the Microscopic Structure of the Older Rocks of Anglesea.
33. *Dr. C. Callaway.*—Notes on the Origin of the Older Archæan Rocks of Malvern and Anglesea.
34. *J. J. H. Teall.*—The Origin of Banded Gneisses.
35. *Howard Fox and Alex. Somervail.*—On the occurrence of Porphyritic Structure in some rocks of the Lizard district.
36. *Prof. W. J. Sollas.*—Some Preliminary Observations on the Geology of Wicklow and Wexford.
37. *G. H. Kinahan.*—On Archæan Rocks.
38. *W. Pengelly.*—Recent Researches in Bench Cavern, Brixham, Devon.
39. *Prof. J. W. Judd.*—The Natural History of Lavas, as illustrated by the materials ejected from Krakatoa.
40. *Dr. H. J. Johnstone-Lavis.*—Report on the Volcanic Phenomena of Vesuvius and its neighbourhood.
41. *Prof. J. Milne.*—Report on the Volcanic Phenomena of Japan.
42. *Dr. T. Sterry Hunt and James Douglas.*—The Sonora Earthquake of May 3, 1887.
43. *Thos. Ward.*—The History and Cause of the Subsidences at Northwich and its neighbourhood in the Salt Districts of Cheshire.

44. *Prof. J. H. Panton.*—Places of Geological Interest on the Banks of the Saskatchewan.
45. *Rev. E. Hill.*—The Disaster at Zug, on July 5, 1887.
46. *Dr. A. Fritsch.*—On the Permian Fauna of Bohemia.
47. *Prof. W. C. Williamson.*—Report on the Carboniferous Flora of Halifax.
48. *A. Smith Woodward.*—On the Affinities of the so-called Torpedo (*Cyclobatis*, Egerton) from the Cretaceous of Mount Lebanon.
49. *Prof. J. F. Blake.*—Description of a New Star Fish from the Yorkshire Lias.
50. *C. E. De Rance.*—Report on the Underground Waters in the Permeable Formations of England.
51. *Prof. Vilanova.*—Notice du *Dinotherium*, deux especes, trouvées en Espagne.
52. *A. H. Foord.*—On the Genus *Piloceras*, Salter, as elucidated by examples lately discovered in N. America, and in Scotland.
53. *J. S. Gardner.*—Report on the Fossil Plants of the Tertiary and Secondary Beds of the United Kingdom.
54. *A. Bell.*—Report on the "Manure" Gravels of Wexford.
55. *R. G. Bell.*—The Pliocene Beds of St. Erth, Cornwall.
56. *J. S. Gardner.*—Report on the Higher Eocene Beds of the Isle of Wight.
57. *W. A. E. Ussher.*—The Triassic Rocks of West Somerset.
58. *W. A. E. Ussher.*—The Devonian Rocks of West Somerset on the Borders of the Trias.
59. *Prof. H. Carvill Lewis.*—The Matrix of the Diamond.
60. *Prof. T. G. Bonney.*—Observations on the Rounding of Pebbles by Alpine Rivers, with a Note on their Bearing upon the Origin of the Bunter Conglomerate.
61. *Prof. W. Boyd Dawkins.*—The Present State of the Channel Tunnel, and the Boring at Shakespeare's Cliff, near Dover.
62. *Prof. Otto Torell.*—On the Extension of the Scandinavian Ice to Eastern England in the Glacial period.
63. *Prof. H. Carvill Lewis.*—On the Terminal Moraine of the Irish-Sea Glacier, near Manchester.
64. *E. P. Quinn.*—Upon a Simple Method of Projecting Microscopic Rock Sections upon the Screen, both by ordinary and by polarized light.

List of Papers bearing upon Geology read in other Sections.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Prof. E. Hull.—On the Effect of Continental Lands in Altering the Level of Adjoining Oceans.

H. C. Russell.—On some Variations in the Level of the Water in Lake George, New South Wales.

E. Douglas Archibald.—The Direction of the Upper Currents over the Equator in connexion with the Krakatoa Smoke-Stream.

SECTION B.—CHEMICAL SCIENCE.

F. W. Clarke.—The Chemical Structure of Natural Silicates.

SECTION D.—BIOLOGY.

Discussion on the arrangement of Museums (in conjunction with Section C), Opened by Dr. H. Woodward, F.R.S., F.G.S.

SECTION E.—GEOGRAPHY.

W. Brindley.—A Visit to the Porphyry Quarries of Gebel Dukhan.

Second Report of a Committee for inquiring into the depth of the permanently frozen soil in the Polar Regions.

Prof. Boyd Dawkins.—The beginning of the Geography of Great Britain.

G. Skelton Streeter.—The Ruby Mines of Burma.

Josiah Pierce, jun.—On the United States Geographical and Geological Survey.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

W. Topley.—On the Future Production of the Precious Metals (at a Joint Meeting with Section C).

SECTION G.—MECHANICAL SCIENCE.

Jeremiah Head.—The Iron Mines of Bilbao.

F. Ransome.—Portland Cement Manufacture.

T. A. Walker.—Severn Tunnel.

SECTION H.—ANTHROPOLOGY.

Sydney B. J. Skertchly.—On the Occurrence of Stone Mortars in the Ancient (Pliocene?) River Gravels of Butte County, California.

Report of the Committee on the Pre-historic Inhabitants of the British Isles.

Dr. Henry Hicks.—The Migrations of Pre-glacial Man.

Dr. H. Colley Marsh.—The Early Neolithic Floor of East Lancashire.

W. Pengelly.—On Recent Researches in Bench Cavern, Brixham, Devon.

Papers Read at the Meeting of the British Association, Manchester, in Section (C), Geology.

II.—THE PLIOCENE BEDS OF ST. ERTH, CORNWALL. By ROBERT GEORGE BELL, F.G.S.

SINCE the publication of the paper read before the Geological Society of London in February, 1886, a good deal of work relating to the geological surroundings and to the special fauna of the deposit has been undertaken. Considerable excavations were made, and much examination given to the sands and clays, with the result that the section given on p. 202, "Quarterly Journal of Geological Society," for May, 1886, was completely verified.

The clay deposit is not, however, uniformly fossiliferous, nor is it uniform in the distribution of its fossil contents as a rule. *Cerithia* are found in great numbers at the base of the blue clay, while the larger *Nassæ* and *Turritellæ* are generally distributed in that bed. A great feature of interest is the large number of the smaller species of mollusca, especially of Gasteropods, which embrace more than three-fourths of the total amount.

Of these small shells the genera *Rissoa* and *Odostomia* are the most plentiful, in species and numbers; about twenty species of the former (including the Hydrobias) and eighteen of the latter genus are present, some being living inhabitants of the British and Mediterranean seas, while others appear new to science, and will have to be described. The *Trochi* are nearly all extinct, three only being Crag and living forms. Of *Nassa* about eight species are present, *Nassa serrata* being by far the most common, and is nearly identical with the general form of *Nassa reticosa*, Sowerby, so plentiful in the coprolite pits of the Boyton district in Suffolk; there are also other well-known Crag species of this family.

The carnivorous Gasteropods are, however, not otherwise plentiful; one should be noticed, a large fragment of *Buccinum undatum*, but no traces of *Fusus antiquus* or *F. gracilis*; all the *Pleurotomas* are scarce except *P. brachystoma*, and there are two species of *Pisania* or *Lachesis*; all these last are southern forms.

Of the bivalves not much can be said; few species were obtained, and these mostly in a fragmentary condition. It is still a difficulty to afford an adequate explanation of this fact, for while the deposit of clay is so well calculated to preserve the shells, as shown by the perfect state of the univalves, the bivalves (if we except the oysters and some minute species) have universally suffered. Some explanation other than that of the physical character of the deposit must be sought for, and none has yet appeared sufficiently satisfying.

The opinion expressed in the earlier reports upon this deposit, as to the southern facies of its fauna, has been amply justified by fresh researches; a large quantity of the fossiliferous clay has been carefully washed and examined, and no trace of northern forms, except *Buccinum undatum*, and the two small species noticed in the paper previously referred to, has been found, while greatly increased evidence confirming what has been already said is present. Had there been any connection with northern seas or colder waters, it would be difficult to understand the entire absence of those forms of *Pleurotoma* (*Bela*) so abundant in the Boreal seas of the Crag period and the present age, as well as the equally characteristic bivalves, *Astarte* and *Cyprina*.

Some conflict of opinion exists upon the depth of water in which the St. Erth clays were deposited.

In a letter to "Nature," of August 12, 1886, a very competent authority on Pliocene phenomena, Mr. Clement Reid, F.G.S., gave it as at least forty or fifty fathoms, founding his view on the evident fact of its deposition in still water, which he maintains could not be found in a district exposed to Atlantic swells at less depth. To this the writer must take serious exception. Undoubtedly the clays exhibit an entire absence of such a disturbing cause as the influence of great wave action, but it remains to be proved that such a great depression as Mr. Reid describes did occur at the western end of Cornwall, and as far as I have been able to observe there is little indication of such a fact. Some depression, of course, must have happened, sufficient to submerge the low-lying land near St. Erth,

causing a strait or gulf, dividing the Land's End from the main eastern portion of the county.

In this shallow strait the clays and sands were deposited, and just such an assemblage of mollusca is found as will bear out this view. Scarcely any of the shells which are of living species are known to inhabit such deep water as Mr. Reid indicates, while the majority show the presence of a laminarian zone, extending to not more than fifteen fathoms. This bathymetrical range is the chosen habitat of the *Rissoæ*, who are all vegetable feeders, and of the *Nassæ*, which are predatory and always plentiful just below low-water mark; and what appears still more conclusive is the number of *Hydrobiæ*, which have a close connection with *Littorina* and indicate shallow depth and close proximity to shore.

It is hoped that a more detailed examination of the mullusca fauna may soon be completed, and the whole series added to the National Collection.

III.—Preliminary Note on Traverses of the Western and of the Eastern Alps made during the Summer of 1887. By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

THE first traverse was made along the line of the Romanche from near Grenoble to the Col du Lautaret, and thence by Briançon over the Mont Genèvre and the Col de Sestrières to Pinerolo at the edge of the Italian plain. The second went from Lienz, across the central range of the Tyrol to Kitzbühel, and the rocks of this range were also investigated at other places, During both traverses the author had the advantage of the assistance of the Rev. E. Hill, who had accompanied him on a similar journey in 1885.

The results of their examination fully confirm the views already expressed by the author as to the nature and succession of the crystalline rocks of the Alps.

(1.) The lowest group consists partly of modified igneous rocks (which indeed occur at all horizons), partly of gneisses of a very ancient (Laurentian) aspect.

(2.) The next group, up to which there seems a gradual passage, consists mainly of more friable gneisses and moderately coarse mica-schists (Lepontine type). This group is commonly less fully developed in the above districts than in the Central Alps, having probably been removed by very ancient denudation.

(3.) The third group has an enormous development. It forms a large part of the Cottian and Graian Alps, and it flanks the central axis of the Eastern Alps on both sides, often passing beneath the ranges of Secondary strata, which here form the northern and southern ranges. It has been traced almost without interruption from east to west for more than fifty miles on the southern, and eighty on the northern side of the central range. It has a very close resemblance in all respects to the uppermost group of schists in the Central Alps, found to some extent in the Lepontine and yet more largely in the Pennine Alps, and the author fully agrees with the Swiss and Austrian geologists in regarding it as in the main

a prolongation of the same series. It is characterized especially by rather dark-coloured mica-schists, often calcareous, sometimes passing into fine-grained crystalline limestones, with occasional intercalated chloritic schists, especially in the lowest part, and with (rarely) quartz schists.

(4.) The Carboniferous and Secondary strata infolded or overlying in the Western Alps section, and the Palæozoic (? Silurian) and Secondary strata succeeding the metamorphic rocks in the Eastern Alps, are comparatively little altered, and are each readily to be distinguished from the above.

(5.) The succession of strata in the third group is inexplicable, unless it be due to stratification; in the second this explanation appears highly probable, and in the first not more difficult than any other.

(6.) As groups of rocks with marked lithological characters occur in like succession over a mountain chain measuring above 400 miles along the curve, and sometimes at distances of 40 miles across it; as these groups correspond with rocks recognized as Archæan elsewhere, which exhibit like characters and sometimes a like order of succession, the author thinks a classification of the Archæan rocks by their lithological characters (using the phrase in a wide sense), may ultimately prove to be possible.

(7.) The views already expressed by the author as to the distinctness of cleavage-foliation and stratification-foliation have been fully confirmed by the examination of the above districts. He believes that the failure to recognize this distinction is the cause of the contradictory statements with regard to the relation of foliation and bedding which have been made by so many excellent observers, and lies at the root of much of the confusion which exists on the subject of the so-called metamorphic rocks.

IV.—Second Report of the Committee, consisting of Professor T. McK. Hughes, Dr. H. Hicks, Dr. H. Woodward, and Messrs. E. B. Luxmoore, P. P. Pennant, Edwin Morgan, and G. H. Morton, Appointed for the purpose of Exploring the Cae Gwyn Cave, North Wales. Drawn up by Dr. H. Hicks, Secretary.

THE main object that the Committee had in view this year was to extend the excavation which had been made in front of the new entrance to the cavern, discovered last year, so that a clear section of the deposits which covered that entrance might be exposed.

Work was commenced on June 6, and continued to the 18th, when it was decided that sufficient excavation had been made, and work was for the time suspended. It was deemed advisable to postpone the shoring up of the sides and any filling in that may be required until August, so that an opportunity may be given to any one interested in the exploration to examine the section exposed. The excavation was visited daily by some members of the Committee, and all, excepting Dr. H. Woodward, were able to be present on

several occasions. The section has also been examined by Prof. Boyd Dawkins, F.R.S., Messrs. C. E. De Rance, F.G.S., R. H. Tiddeman, F.G.S., Clement Reid, F.G.S., A. O. Walker, F.L.S., H. C. Beasley, and others.

It was found necessary to remove much of the timber placed last year to support the face in front of the entrance, so that the section might be clearly exposed, and the cutting was widened here sufficiently to show a vertical face of undisturbed deposits. The timber supporting the north-east face of the cutting was allowed to remain, as that portion had been well exposed last year, and it was thought that the excavation in front and to the south-west would yield all necessary evidence without incurring that additional trouble and expense. The cutting was carried in a south-south-west direction from the mouth of the cavern, and beyond the dip in the field supposed to indicate the line of an old fence; the length from the timber on the north-east face to the commencement of the dip in the field being about 30 feet and the width varying from 5 to 10 feet; the narrowest part being at the furthest point from the cavern. In the face exposed in front of the entrance, and for a distance in the cutting from there of about 25 feet, the soil varied in depth from 18 inches to 2 feet, but at the slope supposed to indicate the line of the old fence it thickened considerably. Underlying this throughout the whole length of the cutting and in the field beyond this point, a boulder clay of reddish-brown colour was exposed. This boulder-clay contained thin seams of sand, which were traceable generally at the same horizon along the whole section.

At a depth of about 7 feet from the surface, in a continuous band of reddish sandy clay, numerous fragments of marine shells and some perfect ones were met with, and these have been recognized by Mrs. McKenny Hughes to belong to the following species, viz. *Ostrea sp.*, *Mytilus sp.*, *Nucula nucleus*, *Cardium echinatum*, *C. edule*, *Cyprina islandica*, *Astarte borealis*, *Artemis exoleta*, *Venus gallina?* *Tellina balthica*, *Psammobia ferröensis*, *Donax?* *Mya truncata*, *Littorina sp.*, *Turritella terebra*, *Buccinum undatum*. Below the boulder-clay at a depth of about 9 feet from the surface, there was exposed some sandy gravel and fine banded sand with a total thickness of over 6 feet, and under the latter a well-defined band of finely laminated reddish clay.

Below the laminated clay the brecciated bone earth was found to extend as far as the cutting was made in front of the entrance, and also for a distance of 7 feet in a southerly direction from the entrance. This year only a few fragments of bone and bits of stalagmite were obtained from this earth, though it will be remembered that last year it yielded many teeth as well as the flint flake which was discovered near the entrance. The limestone floor under the bone earth was found to rise gradually outwards from the mouth of the cavern for some distance, forming a shallow basin-shaped space in front of the entrance. In the bone earth in this space there were several large angular blocks of limestone.

It was not thought necessary to dig down to the floor along the

whole length of the cutting, but it was traced for 7 feet in that direction by the side of the cliff against which the deposits abutted. Beyond that point the cutting was made deep enough to reach the sandy gravel under the boulder-clay, and at different parts test-holes were sunk still deeper into the gravel and sand. One hole was also sunk in the field in front of the cutting at a distance of over 35 feet from the entrance to the cavern. The deposits here were found to be similar to those in the cutting and in front of the cavern, but the depth of the soil over the boulder-clay was only from one foot to 18 inches. A very large number of smoothed and ice-scratched boulders were found, many of considerable size; the majority being fragments of Wenlock shale from the neighbourhood, and Lower Silurian rocks from the Snowdonian area. Amongst them also were fragments of granite, gneiss, quartzites, flint, diorites, basalts, Carboniferous rocks, etc.

V.—The Disaster at Zug on July 5, 1887. By the Rev. E. Hill, M.A., F.G.S., of St. John's College, Cambridge.

ON July 5, 1887, at the town of Zug, in Switzerland, a portion of the shore gave way and sank into the lake. About three hours later another much larger adjacent area also suddenly subsided, so that in all an area considerably over two acres, with half of one of the principal streets, was submerged to a depth of about 20 feet. It can be seen that the subsoil consists of coarse gravel and sand, followed after a few feet by soft wet sand and fine mud. According to Professor Heim, this fine mud or sludge reaches to a depth of nearly 200 feet, and the disaster is shown to be due to a flowing out into the lake of this mobile sludge from under the superincumbent weight of buildings and firmer ground. The buildings collapsed as they sank. The catastrophe must have been long impending; the exact cause which precipitated it is indeterminate, but a low level of the lake and tremors from pile-driving for new quays are suggested as contributories. On the English coast the incessant changes of pressure from tides probably render impossible such instability of equilibrium.

REVIEWS.

The Mammoth and the Flood. An Attempt to Confront the Theory of Uniformity with the Facts of Recent Geology. By Henry H. Howorth, M.P., F.S.A., M.R.A.S. 8vo. pp. xxxii. 464. (London, 1887, Sampson Low, Marston, Searle, and Rivington.)

THE desire to find harmony between the Geological record and the first chapter of Genesis, laudable enough when Science was in its infancy, has ceased now-a-days to cause much anxiety. Geological chronology, like human history, can only be separated into epochs that are marked by local breaks or "landmarks" in the continuity of events; so that no system of subdivision that applies to one tract of the earth's surface will be equally applicable in all countries.

Even when such terms as Silurian, Jurassic, and Cretaceous are employed in all quarters of the globe, it must not be inferred that the periods embraced can be limited in the same way as they are in this country. With the later epochs of Pleistocene and Recent, it is possible, however, to speak more confidently, though in a general way, of contemporaneous forms of life.

Mr. Howorth candidly dismisses the first chapter of Genesis as "absolutely valueless in geological discussion"; but, granting this to be the case, he adds, "there is no reason whatever why subsequent chapters which profess to report, not how things arose before man appeared, but the traditions of man himself, should be discarded." Thus approaching his subject, the author continues, "To speak more definitely, the Flood, as reported in the Bible, is undoubtedly a very old tradition, it is in correspondence with similar traditions among widely separated peoples, *between whom there has been no intercourse, so far as we know*, at least since the first dawn of history. These traditions generally agree in placing a great catastrophe, involving widespread destruction to animal life, at the verge of human memory. Such widespread and continuous traditions need explanation." At the outset we are disposed to question the value of the traditional evidence, so far as it suggests "a deluge apparently unparalleled in extent and completeness in any other geological period"; for the words we have placed in *italics* indicate a flaw in that evidence, as the ideas held by the various peoples may have been transmitted from one independent source, and not have originated simultaneously all the world over. Be this as it may, the main object of the work before us is to bring forward facts to prove that a very great cataclysm or catastrophe occurred at the close of the Mammoth period, by which that animal with its companions, were overwhelmed over a very large part of the Earth's surface; that this catastrophe constitutes the gap which is almost universally admitted to exist in Northern Europe between so-called Palæolithic and Neolithic man; and that while this flood was exceedingly widespread, considerable areas escaped, and from these insular areas man, animals, and plants spread out again and reoccupied those districts which had been desolated.

We may pass over those portions of the work that deal with the etymology of the word Mammoth and its identity with Behemoth; or that review the old records of fabulous beasts and giants, based on the discoveries of huge bones. These accounts, together with the speculations on the origin of the bones, furnish a good deal of interesting matter.

The author is evidently quite "at home" with "the Mammoth in Siberia," and he gives full and instructive accounts of the discoveries of bones and frozen carcases ("Mammoth Mummies"); of the trade in fossil ivory; and of the physical features of the land. The larger portion of Northern Siberia, as is well known, consists of flat tracts, known as *tundras*, upon which few if any trees will grow. The areas are covered with moss, and they are swept by icy winds. The ground is in parts frozen to a depth estimated at 630 feet, although

in the summer season it may be thawed to a depth of three feet. In several cases Mammoth carcases have been found standing upright in the ground, as if they had sunk down and been frozen in that position; in other cases remains of various animals are commingled in the frozen soil and must have been drifted some distance, before being embedded in the black earth, sand, or icy clay. There is evidence also of much drift wood, as well as of large tree-stems, to indicate that the climate formerly was more favourable to vegetation than it now is. The animals represented by the frozen carcases, must have been overwhelmed and have been rapidly enveloped in mud and gravel, and the ground must have become frozen, and remained so until the present day. There appears no escape from this conclusion, though it is difficult to say in what way the animals were overwhelmed and how long they have been embedded. As Mr. Howorth remarks, no Russian naturalist holds the view that the Mammoth lived on to Recent times in Siberia.

The facts pointed out by our author are opposed to the view that the Mammoth and other animals were, as a rule, drifted far from the south, for the remains are found not only on the banks of the long rivers, but also abundantly on the borders of the very short ones, and in nearly all parts of the tundra. Mr. Howorth concludes that the Mammoth and his companions lived for the most part where their remains occur in northern as well as in southern Siberia, but under different climatal conditions. He says (p. 96), "We cannot postulate a separate climatic cataclysm for each individual case and each individual locality, but we are forced to the conclusion that the now permanently frozen zone in Asia became frozen at the same time from the same causes." While we feel with the author that diluvial agents may reasonably be inferred in order to account for the remarkable entombment of many organic remains, yet we are not prepared to go so far as he does, and to regard the phenomena generally as "the result of one of Nature's hecatombs on a grand and wide-spread scale, when a vast fauna perished simultaneously."

The fact is, our author would lead us all round the world, and taking the Pleistocene fauna, which we admit in a general way to be contemporaneous, he would have us believe that the bulk of the animal remains were smothered up at one time in "the Great Flood." Not only were the remains of Mammoth and Rhinoceros found in brickearth and gravel and in Cave-earth, over the north of Europe, entombed by this cataclysm; but the bulk of the Pleistocene remains in North and South America, in Australia, Tasmania, and New Zealand were covered up at one and the same time! In other words the Mastodon and Elephant, the *Megatherium*, the *Diprotodon* and *Nototherium*, and the Moa also, perished in one general catastrophe!

The author bases his views partly on the general mode of occurrence of the fossil animal remains, their abundance in certain places, and the commingling of various genera; but as he observes the present volume only deals with one-half of the problem, namely, that illustrated by palæontology and archæology. In interpreting this or any other geological record, the stratigraphical evidence is of

the highest importance, but that is not now put before us, the author hoping to treat the geological side of the case fully and completely in a subsequent volume, when he will discuss the cause of the catastrophe and its extent. In the meantime he observes that "This vast effort seems from inexorable evidence to have been due to the exertion of some cataclysmic force by which the Earth's crust was greatly disturbed, not merely locally, but over a large part of its surface. It was in consequence of this dislocation that the loose watery envelope which covers a large portion of the world was set in motion, and sweeping over the land drowned and then buried deep in gravel, loam and clay, hecatombs of living beings."

All this is of course very vague and hypothetical. The relations of the Mammoth and its companions to the Glacial period form an exceedingly important subject, but the questions that Mr. Howorth raises concerning them cannot be discussed until his second volume comes to light. He however so far anticipates himself as to speak of the Mammoth age as the true Glacial epoch, and to remark that he is "completely opposed to the extreme views urged in recent years by Agassiz, Croll, James Geikie," and others, whose views he regards as a "glacial nightmare."

Nevertheless, whatever opinions be held with regard to the relative influence of land-ice, coast-ice, and icebergs, there can be no reasonable doubt that all agents have acted a part in the history of the Glacial period. Moreover, that epoch must have lasted thousands of years. The records of tumultuous deposits are interwoven with those of quiescent deposits, and in a broad and general—we might say *poetic*—way it would not be very rash to speak of this period as Catastrophic. Compared with what is now going on in this country, no doubt the Glacial period was decidedly catastrophic, and we feel convinced that excessive denudation and deposition must have taken place far and wide over the surface of our land. Indeed, we believe with Mr. Howorth, that the Glacial period coincides generally with that of Palæolithic man; and it is not unreasonable to suppose, as Mr. Tiddeman has suggested, that extensive floods in those days gave rise to the tradition of a Universal Deluge. More than this we are not prepared to admit, nor can we agree with the author when he says that "over much the largest portion of the earth's surface which is covered and protected by herbage or forest, denudation is not going on at all, but on the contrary *humus* is being deposited in a more or less slow fashion." This is a very misleading statement, inasmuch as the author entirely neglects the effects of subterranean denudation: for we need only point to the solid matter carried away in solution and suspension by springs and rivers, much of which sedimentary matter is derived from lands covered and protected by herbage. There can be no doubt that the level of the land is in places gradually lowered without the general surface contour being visibly affected.

Another point on which the author places considerable stress, is that remains of animals are not now-a-days preserved to the extent they were during "the Great Flood." The facts that "in Spitzbergen

it is easier to find vertebræ of a gigantic Lizard of th e Trias than bones of a self-dead Seal, Walrus, or Bird," or that in the forests of Ceylon remains of Elephant are rarely if ever found, simply show that conditions for the preservation of the bones did not locally exist. At Lyme Regis it would be easier to find Saurian remains in the Lias, than Mammoth bones in the old gravels of the neighbouring valleys, or than remains of Bear, Wolf, and species of animals still existing, in the more recent Alluvial deposits. We should be surprised rather than otherwise to find bones preserved on the surface "in subaerial layers," excepting those bones which have been buried, and it is far from strange "that the plough, in cutting through virgin soil," seldom meets with them. Throughout the history of all our stratified rocks fossils are more abundant at particular spots even in the same stratum, just as we find recent shells abundantly on our beaches at some localities, while they are absent at others. Mr. Howorth might visit many a section in our older Thames Valley deposits and return home without any osteological reward; and he might meet with similar experience in searching for bones in the Norwich Crag, or even in the Cromer Forest Bed.

In other instances bones are locally very abundant, and sometimes represent animals in various stages of growth. This again is quite natural, for land-animals that die of old age would, as a rule, perish in situations where their bones would not be preserved. We are, however, quite disposed to agree with the author when he maintains that "The occurrence of immense caches in which the remains of many species of wild animals are incongruously mixed together pell-mell, often on high ground, seems unaccountable, save on the theory that they were driven to take shelter together on some point of vantage, in view of an advancing flood of water, a position which is paralleled by the great floods which occur occasionally in the tropics, where we find the tiger and its victims all collecting together on some dry place, and reduced to a common condition of timidity and helplessness by a flood which has overwhelmed the flat country."

Most of the Pleistocene Mammalia found in this country have been obtained in deposits that occur in caverns or in the drainage areas of modern rivers; and we dispute the statement, that in many places in this country, "we find the caches of bones in positions entirely out of the reach of any possible rivers or river-floods." Nor is it generally the case that the beds in which Palæolithic implements occur are found in situations where no river flows, and where no river that we can postulate as possible ever could have flowed.

These dogmatic statements are certainly inconsistent with the general tenor of the author's remarks, and we hope in his second volume he will not be led to quote exceptional and disputed cases in support of his particular views.

From the facts brought before us in this volume, we cannot discern any immediate connection between the accumulations formed by the direct agency of ice, such as the widespread deposits of Boulder-clay and the entombment of the various Pleistocene mammalia. And this view is in concord with Mr. Howorth's statement (p. 100) that "Speaking roughly, remains of the Mammoth are absent or

the highest importance, but that is not now put before us, the author hoping to treat the geological side of the case fully and completely in a subsequent volume, when he will discuss the cause of the catastrophe and its extent. In the meantime he observes that "This vast effort seems from inexorable evidence to have been due to the exertion of some cataclysmic force by which the Earth's crust was greatly disturbed, not merely locally, but over a large part of its surface. It was in consequence of this dislocation that the loose watery envelope which covers a large portion of the world was set in motion, and sweeping over the land drowned and then buried deep in gravel, loam and clay, hecatombs of living beings."

All this is of course very vague and hypothetical. The relations of the Mammoth and its companions to the Glacial period form an exceedingly important subject, but the questions that Mr. Howorth raises concerning them cannot be discussed until his second volume comes to light. He however so far anticipates himself as to speak of the Mammoth age as the true Glacial epoch, and to remark that he is "completely opposed to the extreme views urged in recent years by Agassiz, Croll, James Geikie," and others, whose views he regards as a "glacial nightmare."

Nevertheless, whatever opinions be held with regard to the relative influence of land-ice, coast-ice, and icebergs, there can be no reasonable doubt that all agents have acted a part in the history of the Glacial period. Moreover, that epoch must have lasted thousands of years. The records of tumultuous deposits are interwoven with those of quiescent deposits, and in a broad and general—we might say *poetic*—way it would not be very rash to speak of this period as Catastrophic. Compared with what is now going on in this country, no doubt the Glacial period was decidedly catastrophic, and we feel convinced that excessive denudation and deposition must have taken place far and wide over the surface of our land. Indeed, we believe with Mr. Howorth, that the Glacial period coincides generally with that of Palæolithic man; and it is not unreasonable to suppose, as Mr. Tiddeman has suggested, that extensive floods in those days gave rise to the tradition of a Universal Deluge. More than this we are not prepared to admit, nor can we agree with the author when he says that "over much the largest portion of the earth's surface which is covered and protected by herbage or forest, denudation is not going on at all, but on the contrary *humus* is being deposited in a more or less slow fashion." This is a very misleading statement, inasmuch as the author entirely neglects the effects of subterranean denudation: for we need only point to the solid matter carried away in solution and suspension by springs and rivers, much of which sedimentary matter is derived from lands covered and protected by herbage. There can be no doubt that the level of the land is in places gradually lowered without the general surface contour being visibly affected.

Another point on which the author places considerable stress, is that remains of animals are not now-a-days preserved to the extent they were during "the Great Flood." The facts that "in Spitzbergen

it is easier to find vertebræ of a gigantic Lizard of th e Trias than bones of a self-dead Seal, Walrus, or Bird," or that in the forests of Ceylon remains of Elephant are rarely if ever found, simply show that conditions for the preservation of the bones did not locally exist. At Lyme Regis it would be easier to find Saurian remains in the Lias, than Mammoth bones in the old gravels of the neighbouring valleys, or than remains of Bear, Wolf, and species of animals still existing, in the more recent Alluvial deposits. We should be surprised rather than otherwise to find bones preserved on the surface "in subaerial layers," excepting those bones which have been buried, and it is far from strange "that the plough, in cutting through virgin soil," seldom meets with them. Throughout the history of all our stratified rocks fossils are more abundant at particular spots even in the same stratum, just as we find recent shells abundantly on our beaches at some localities, while they are absent at others. Mr. Howorth might visit many a section in our older Thames Valley deposits and return home without any osteological reward; and he might meet with similar experience in searching for bones in the Norwich Crag, or even in the Cromer Forest Bed.

In other instances bones are locally very abundant, and sometimes represent animals in various stages of growth. This again is quite natural, for land-animals that die of old age would, as a rule, perish in situations where their bones would not be preserved. We are, however, quite disposed to agree with the author when he maintains that "The occurrence of immense caches in which the remains of many species of wild animals are incongruously mixed together pell-mell, often on high ground, seems unaccountable, save on the theory that they were driven to take shelter together on some point of vantage, in view of an advancing flood of water, a position which is paralleled by the great floods which occur occasionally in the tropics, where we find the tiger and its victims all collecting together on some dry place, and reduced to a common condition of timidity and helplessness by a flood which has overwhelmed the flat country."

Most of the Pleistocene Mammalia found in this country have been obtained in deposits that occur in caverns or in the drainage areas of modern rivers; and we dispute the statement, that in many places in this country, "we find the caches of bones in positions entirely out of the reach of any possible rivers or river-floods." Nor is it generally the case that the beds in which Palæolithic implements occur are found in situations where no river flows, and where no river that we can postulate as possible ever could have flowed.

These dogmatic statements are certainly inconsistent with the general tenor of the author's remarks, and we hope in his second volume he will not be led to quote exceptional and disputed cases in support of his particular views.

From the facts brought before us in this volume, we cannot discern any immediate connection between the accumulations formed by the direct agency of ice, such as the widespread deposits of Boulder-clay and the entombment of the various Pleistocene mammalia. And this view is in concord with Mr. Howorth's statement (p. 100) that "Speaking roughly, remains of the Mammoth are absent or

exceedingly scarce in the area bounded on the east by Lakes Onega and Ladoga, an area where the Boulder-drift prevails." That floods of considerable magnitude may have taken place, again and again during the Glacial period, is more than likely; but the stratigraphical and physical evidence in support of the Great Flood, as pictured by Mr. Howorth, has yet to be made known.

Mr. Howorth has given lists of the Pleistocene Mammalia from various parts of the world, a task which we can readily admit has given him a great deal of patient labour. Nor was his task at all lightened by the uncouth names so profusely applied to the genera and species. On this subject he seeks to comfort his troubled mind by remarking, "Surely we are nearing a time when the man who coins a new species without abundant excuse will be deemed a scientific criminal, and when the ambition to flood text-books with lists of names of one's own invention will cease to be called science, and be treated as mere child's play."

In addition to the Mammalia, other organic remains, including the Plants of Pleistocene times, are more or less fully recorded.

The author loses no opportunities of entering and repeating his protests against "the creed of English Uniformitarians." In this respect he is not alone, we think, in somewhat needlessly spending a good deal of energy; his views, after all, as he points out, coincide with those advanced by Prof. Huxley more than eighteen years ago in an address to the Geological Society of London. Moreover, the elementary facts to which Mr. Howorth alludes (p. xv), such as the sudden creation and rapid disappearance of the submarine island near Santorin, are clearly not opposed to the teachings enunciated by Lyell, and they do not "strain the theory of Uniformity to the breaking point." Geologists do not argue "that the present forces which are busy with the Earth's crust are the measure of what they have always been," but they do hesitate to introduce "abnormal" causes, or tools that are not known to exist in Nature's workshop, to explain phenomena that can be accounted for by known agents.

Notwithstanding our objections to the very sweeping conclusions drawn by Mr. Howorth, his work will be of great value as a storehouse of facts on the fauna and flora of Pleistocene times. The book is well printed on thick paper and neatly bound. Its value, however, as a work of reference is seriously damaged by the lack of an index: but perhaps the author can remedy this when he brings out his second volume.

CORRESPONDENCE.

NAMES OF BONES REVISED.

Sir,—In "The Ornithosauria," 1870, pl. xii. figs. 12, 13, I gave two views of a fragment of bone, which is described as follows: "Undetermined [? pterygoid end of palatine bone]." This fragment I now know to be the radial crest of an Ornithosaurian humerus.

In the Quarterly Journal of the Geological Society, 1877, vol. xxxii. p. 716, is an account of *Pliosaurus Evansi*. A bone in that

paper, which is described and figured as a left ischium (pp. 721–3, figs. 7–9) is the left coracoid.

In the Geological Magazine, February, 1887, p. 84, the humerus of *Pelorosaurus* is referred to *Cetiosaurus*. I had previously, in the Quarterly Journal of the Geological Society, 1882, vol. xxxviii. p. 371, regarded the same bone as referable to *Ornithopsis*, and to that determination I adhere. *Cetiosaurus* is well known to be allied to *Ornithopsis*, but I am aware of no evidence of the presence of *Cetiosaurus* in the Wealden deposits, in which the type is represented by species of *Ornithopsis*. H. G. Seeley.

24th August, 1887.

PARALLEL STRUCTURE IN IGNEOUS ROCKS.

Sir,—I am obliged to Mr. Harker for the information given in his letter in your August Number. I do not see the American Journal of Science, and was not aware that Prof. Dana had partially modified his views, or that Mr. G. H. Williams had by observations on the ground come to the conclusion that the igneous rocks of Cortland were sharply separable from the adjacent crystalline schists. It need hardly be pointed out that this coincidence of opinion between Mr. Williams and myself is of considerable evidential value. Ch. Callaway.

Wellington, Shropshire, *September 17th*, 1887.

OBITUARY.

EDWIN WITCHELL, F.G.S.,

Treasurer of the Cotteswold Naturalists' Field Club.

It is with deep regret that we have to announce the sudden death, on the 20th August last, of Mr. Edwin Witchell, solicitor, of Stroud, at the age of sixty-four. Mr. Witchell was a son of Mr. Edward Witchell, of Nymphsfield, a well-known and highly-respected yeoman, and was born in June, 1823. His tastes from early boyhood led him more to the study of books than to the cultivation of the soil; at the early age of thirteen years he was placed in the office of Mr. Paris, of Stroud, the chief local solicitor of those days. Later on he was articled to that gentleman, and ultimately succeeded to his practice in 1847. He was at one time very fond of hunting, and used frequently to accompany the late Mr. Paul Hawkins Fisher in some of the most memorable runs of the adjacent packs of foxhounds. This exhilarating sport doubtless contributed to his then robust health; but as years crept on, Mr. Witchell gave up his hunter and applied himself assiduously to rambles in pursuit of his favourite science of Geology. About five years ago, when climbing in a dangerous part of the cliffs at Lyme Regis, heart trouble set in, and for three or four years he has suffered from angina pectoris, but had not been incapacitated from business, nor deterred from carrying on his geological work. And it was while engaged in collecting fossils from the Inferior Oolite at Swift's Hill, near Stroud, that Mr. Witchell overtaxed his strength, and fell amidst the rocks to which he had devoted so much study. In the neigh-